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THE RAPID TRANSIT TUNNEL for New York, as proposed by Mr. GREATHEAD, the English engineer, says Mr. SIMON STERNE, would cost $1,000,000 per mile for two tunnels with a track in each, or $2,000,000 per mile for four tracks in four parallel tunnels. The first estimate covers stations, rolling stock and a general equipment ready for service. An estimate for a four-track road, 10 miles long, would be $20,000,000 as a maximum; $40,000,000 would build two four-track roads, says Mr. STERNE, which would do infinitely more business than the present elevated roads which are capitalized at $80,000,000. The time for construction estimated is 2½ years from the Battery to the upper end of Central Park. This is the deep tunnel scheme referred to in an editorial note in this issue, written before this detailed estimate appeared.

A RAPID TRANSIT SCHEME FOR NEW YORK, suggested by Mr. DAVID H. KING, has colossal proportions, as far as the money required is concerned. Mr. KING, however, thinks nothing is expensive that will pay 5% on its bonded indebtedness. He proposes an arched masonry viaduct, 50 ft. or more high and 100 ft. wide, inside the house line of streets bounding the entire water front of Manhattan Island. For the central line he would acquire a strip 75 ft. wide through blocks, and on this build a depressed 4 or 6 track road. He would expect to rent the arches for warehouses, and line the depressed road with shops and arcades.

THE HYDRAULIC HOISTS, on the new City & South London Railway, are twelve in number, says *Engineering*, two at each of the six stations on this 3-mile line, and vary in lift from 43 to 67 ft. The two hoists work in a circular shaft 25 ft. in diameter and each cage is semicircular in form, with a length of 22 ft., width of 9 ft. and height of 11 ft. The cages are framed in steel and fitted in polished mahogany and pitch pine. The two hoists in each shaft are entirely independent of each other, and the combined strength of the 6 steel wire ropes attached to each cage is 320 tons. Four of these ropes are connected with the hydraulic cylinder and two with the counterbalance weights. The hoists at all six stations are operated by pumping engines at the Stockwell depot, the water being conveyed under a pressure of 70 atmospheres in pipes of such ample size as to secure a quite inconsiderable loss from friction. These pipes pass through the tunnel and this high pressure water is used for clearing the tunnel of water leaking in by the adoption of a modification of the Greathead & Martindale injector fire hydrant.

THE HUDSON RIVER TUNNEL, to Jan. 1, shows a total progress of 2,720 lin. ft. out of 5,500 ft. under the Hudson River. The progress for some months past has been about 7 ft. per day of 24 hours. The shield is reported as working well, and the engineers expect an advance of 10 ft. per day under a new system of car loading now being put into operation.

THE TEMPORARY INJUNCTION AGAINST THE PURCHASE by the city of Brooklyn of the works of the Long Island Water Co., brought by Mr. WILLIAM ZEIGLER, a tax-payer, has been made permanent by Judge BARTLETT, of the Supreme Court. The case will probably come up in the courts for trial on its merits. The injunction was made permanent on the ground that the payment of $750,000 for the company's stock and the assumption of its $500,000 of 6% bonds would be a wasteful expenditure of the city's money. Further particulars were given in these columns last week.

THE REFUSE "DESTRUCTOR," erected by the Glasgow corporation last month, is the the third in use by the Corporation Sanitary Department. It is situated on the line of the North British and Caledonian railways. The works are built on sloping ground, says the London *Contract Journal*, and the refuse is deposited at the highest point. This refuse falls from the carts through a short shoot, into a revolving screen from which all the finer portions pass into a mixer, which receives other manurial refuse, and is there formed into a kind of compost sold to farmers. The cinder is extracted from the finer material and is used as fuel for running the whole works. The rougher rubbish falls on an endless web of plates and chains, which travels about 36 ft. per minute. As it passes along on this carrier, meat-tins, old iron and anything that can be utilized is picked out and the remainder goes into furnaces. The department mentioned deals, in all, with about 750 tons of rubbish per day. These last works cost $80,000, including buildings, machinery, etc.

THE THIRD ANNUAL CONVENTION of State Railroad Commissioners will be held in Washington at the office of the Interstate Commerce Commission, beginning March 3. Members of or delegates from the Association of Railway Accounting Officers are also invited to be present. The subjects purposed for discussion are as follows:

1. "Railway Legislation": How harmony therein may be attained. 2. "Uniformity in Railway Accounts": What further is important to that end. 3. "Territorial Assignment of Statistics of Operation": Whether this is not practicable, and what principles should control in grouping railway statistics. 4. "Apportionment of Expenses to Freight and Passenger Traffic": What reasons there are for making such an apportionment, and what rules should be adopted. 5. "Safety Appliances for Railroad Cars": What legislation, if any, should be had by Congress. 6. "Reasonable Rates": What are, and the elements to be considered in the determination thereof.

A DRIVING WHEEL TIRE of an engine on the New York, Lake Erie & Western R. R., is reported to have come off the wheel recently while the engine was hauling a train near Pond Eddy, Pa. According to the account, the tire ran down the bank and crashed through the wall of a house.

THE MOST SERIOUS RAILWAY ACCIDENT OF THE WEEK occured Jan. 1 on the Delaware, Lackawanna & Western R. R., near West Paterson, N. J. An express train was turned onto a side track by a misplaced switch, and ran into a train of flat cars loaded with pig iron. Three men were injured. The switch is said to have been forced open by train wreckers. A rear collision occurred on the New York elevated railway at 155th St. and 8th Ave. on Jan. 2. The accident occurred during a fog. The rear end of the engine of the second train was crushed by the cars behind, and the fireman was fatally injured. On Jan. 3 the eastbound Chicago and New York express on the Pittsburg, Fort Wayne and Chicago R. R. was derailed near Massillon, O.; the engine and all the cars left the track, but fortunately the train was soon stopped and nobody was injured. The accident is said to have been caused by the breaking of a spring rail frog.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: On Jan. 3 a freight train on the Kanawha & Michigan Ry. was derailed on a bridge at Dexter, O., the bridge was wrecked and 4 cars went down. A freight train on the Pittsburg & Lake Erie R. R. was derailed Jan. 3 on a trestle near Rankin, Pa., and 77 cars went over. An express train on the Chesapeake & Ohio Ry. went through a trestle near Stepstone, Ky., Jan. 6; two men were killed, and the baggage car and engine was destroyed by fire. Several bridges in West Virginia have been washed away by floods and the falseworks of the channel span of the new bridge over the Kanawha River at Charleston, W. Va., were carried away by driftwood Jan. 2.

A MILLDAM at Stony Brook, Long Island, N. Y., gave way Jan. 2, and the rush of water caused considerable damage.

THE BALDWIN LOCOMOTIVE WORKS, of Philadelphia, have lately torn down 76 dwelling houses adjoining their old works and have replaced these by a new shop building, four stories high and 287 and 208 ft. long and 50 ft. wide, on the L thus formed. The cost of this addition to their already very extensive works is given as $240,000.

THE LOCOMOTIVES FOR THE NEW SOUTH WALES GOVERNMENT RAILWAYS, which have recently been built by the Baldwin Locomotive Works, of Philadelphia Pa., are of the following dimensions. There are 12 ten-wheel passenger engines and 20 consolidation freight engines. Passenger engines: Cylinders, 21 × 24 ins.; diameter of driving wheels, 61 ins.; diameter of truck wheels, 30 ins.; straight boiler, 62 ins. diameter; firebox, 120 × 33⅛ × 61 × 76⅛ ins.; about 270 tubes, 2 ins. diameter and 13 ft. long; grate area, 29.3 sq. ft.; heating surface, 1,926⅛ sq. ft.; weight on driving wheels, 97,500 lbs.; on truck, 32,500 lbs. Freight engines: Cylinders, 21 × 26 ins.; diameter of driving wheels, 51 ins.; diameter of truck wheels, 30 ins.; straight boiler, 64 ins. diameter; firebox, 112 × 42 × 58 × 62 ins.; about 231 tubes, 2¼ ins. diameter and 13 ft. 4⅛ ins. long; grate area, 32·6 sq. ft.; heating surface, 1,967 sq. ft.; weight on driving wheels, 122,000 lbs.; on truck, 16,000 lbs. The tenders of all the engines are carried on 33-in. truck wheels; the weight is 72,000 lbs., and the tank has a capacity of 3,600 galls. Both passenger and freight engines are fitted with hand screw brakes, and with the American Brake Co.'s brake, operated by air pressure in connection with the Westinghouse air brake.

THE EXTENSIVE SYSTEM OF RAILWAYS FOR CHILE, the contracts for which were awarded in 1888, is in course of construction. The contract was awarded to the North & South American Construction Co., of New York, but we learn from Mr. BEELEN, Consul-General for Chile, that the work is being carried on by the government, on the company's account. The company is responsible for the carrying out of the work, and should there be a deficit it will have to reimburse the government. The new lines will aggregate about 780 miles, and they may form a part of the proposed line of railway to connect the United States and Mexico with Central and South America. The new Chilian railways were described in ENGINEERING NEWS, Nov. 10, Nov. 24, and Dec. 8, 1888.

THE BUENOS AYRES & VALPARAISO TRANSANDINE RY. is progressing. At a meeting of the company in London, in December last, it was stated that satisfactory progress had been made in Chile with the line from Santa Rosa station, on the Chilian Ry., toward the pass, so that the termini on either side of the Andes would soon be within a short journey of each other by road. The line was originally laid out to pass over the summit of the Cordillera by a somewhat circuitous route, but this was found objectionable for many reasons, and the new plan adopted, which has been approved by the Government, involves the construction of tunnels. These are now being proceeded with on the Argentine side with considerable activity. At the end of September a total length of 1,265 meters had been made, and a heading driven still farther. It is hoped to have the Chilian section completed early this year.

The New Prospect Storage and Distributing Reservoir, at Buffalo, N. Y.

The city of Buffalo, N. Y., is supplied with water from the Niagara River by direct pumping and pumping to a reservoir. The population of the city has increased from 155,000 inhabitants in 1880 to 256,000 in 1890, or about 65%. In the same period the number of miles of water mains has increased from 102 to 300 miles. The consumption, or the total pumpage, has increased from 14,496,815 galls. in 1879 to 45,071,911 galls. in 1889. During this growth in population, extension of system and increasing consumption the reservoir capacity has not been changed, but stands as in 1880 at 14,000,000 galls.

As early as 1874 the city realized that a larger reservoir would eventually be necessary, and in that year purchased a piece of land known as the Dodge Farm, as a future site for a reservoir. In 1888 plans for a new reservoir were made or begun, and in 1890 construction was started and continued until Dec. 1, when it was stopped by cold weather, the reservoir then being about half completed. The contract provides for the completion of the reservoir by Dec. 1, 1891.

The reservoir will have a capacity of 135,000,000 galls. It and the embankments together will cover about 22 acres of land. It is nearly rectangular in shape, as shown by the accompanying plan, and the water has a depth of from 35 to 41 ft. It is in excavation and embankment, the latter being 12 ft. wide on top, including the lining and paving. The embankment is in two sections, that next the water being the front and the other the rear section. The front section extends from the foot of the inner slope to a line perpendicular to the top of the embankment and extending downward from the rear top angle.

All the ground covered by the reservoir and embankments was first cleared of trees, stumps, stones, turf and similar objectionable matter, and also of the "soil." Under the front section all porous or objectionable earth was removed in accordance with the engineer's orders. The front section of the bank is formed, generally, of clay, gravel and loam or coarse sand in equal parts, puddled and rolled in 4-in. layers. The rear section is of inferior material from the excavations, mixed with loam, wet and rolled in 4-in. layers. The rollers used are of iron, grooved, and weigh two tons each. Parts that cannot be reached with rollers are rammed. Around the reservoir, on the street line, a masonry retaining wall, 10 ft. high, will be built. It will show a rock face, with a slight batter, and will have a coping of dressed stone 3½ ft. wide and not less than 12 ins. deep. It will have a concrete base 1 ft. thick.

There will be a gravel walk on top of the embankment, 4 ft. wide, the gravel to be 8 ft. deep. The remainder of the top of the embankment and the outer slope will be seeded to grass. The inner slope will be paved with 8 ins. of sandstone in cement, resting on from 12 to 18 ins. of gravel.

The location and details of the inlet and outlet pipes, one each, are shown by the accompanying plans and sections. The inlet pipe will be on a higher level than the outlet, and the former will also be arranged so that it can be used as an outlet pipe. The pipes will each have an internal diameter of 3 ft. and a 1⅝-in. shell; the ends of the lengths will be flanged and bolted together. They will be made of twice melted cast-iron. The inner end of each pipe curves upward and is covered as shown by the illustrations. The outer ends of the pipes branch into a 30 and a 24-in. pipe, the latter connected in each case with the sewer. Each is provided with a valve, as is also each pipe at the point where it passes out from under the reservoir embankment.

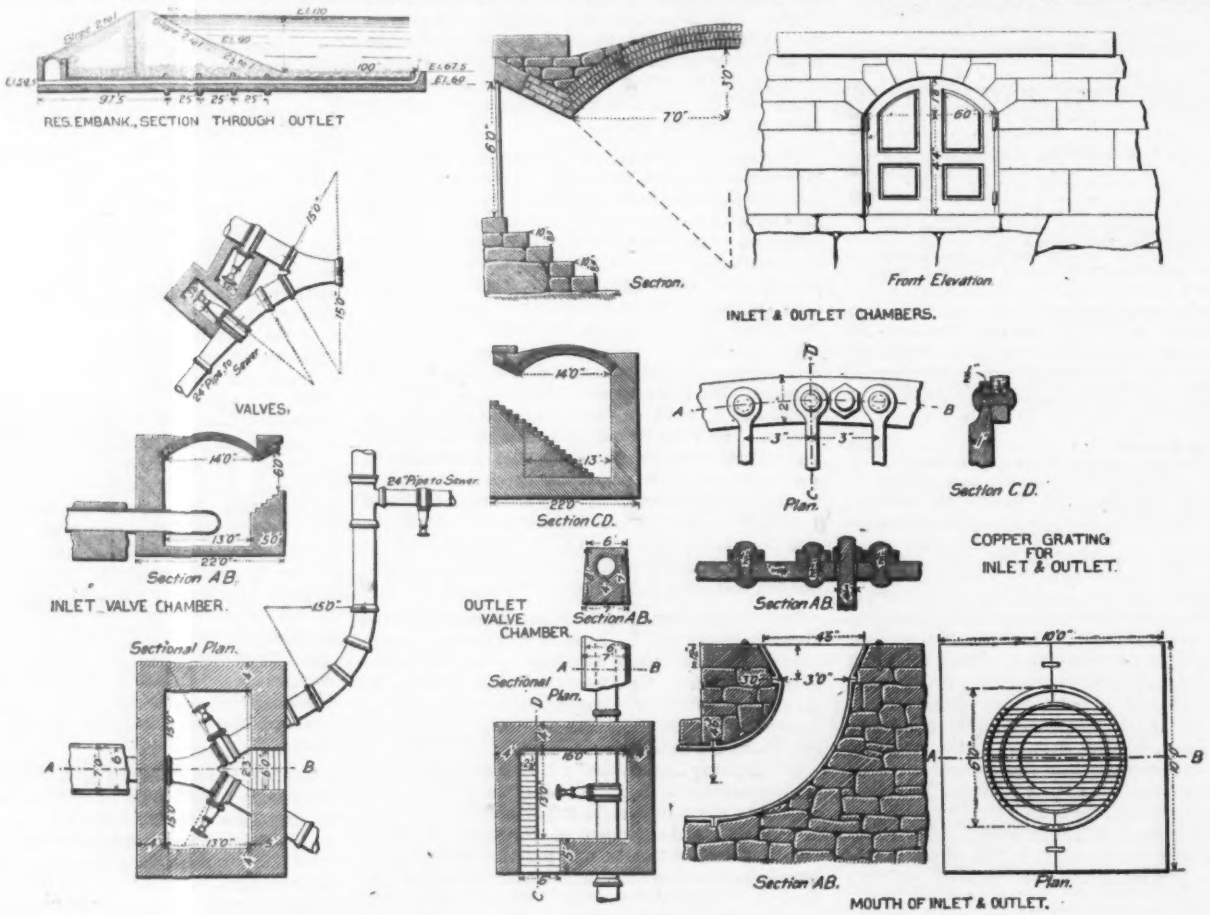
That portion of each pipe between its mouth and the embankment valve chamber is enveloped in and rests upon a wall of hydraulic masonry in cement mortar, 8 ft. high, 7 ft. wide at the bottom and 6 ft. at the top, with three wall belts, or cut-off walls, for the inlet, and four for the outlet. Each cut-off is 2 ft. thick and extends 2 ft. beyond the wall proper. The embankment valve chambers are built as shown. They are each 13×21 ft. on the inside, with arched brick roofs.

The specifications leave optional with the engineer the laying of a pavement of brick, flat, in a bed and with joints of hydraulic mortar, the whole on 10 ins. of fine gravel and coarse sand; or the water commissioners may direct that instead of a brick pavement 2 ins. of double screened fine clean gravel be spread over the layer previously mentioned, and if they so direct that this shall be covered with ½ in. of thick hydraulic mortar.

The nature and amount of labor involved in the construction of the reservoir are shown by the following estimates of quantities:

Earth excavation, put into embankments	453,833	cu. yds.
Earth excavation, clay in pits put into embankments	75,800	"
Gravel and very coarse sand	28,562	"
Masonry	6,104	"
Concrete	768	"
Stone paving, 8 ins. thick	32,156	sq. ft.
Brick paving, flat	44,471	"
Soiling and seeding	27,465	"
Gravel walk, 4 ft. wide, 8 ins. deep	3,635	lin. ft.
Stone coping, 12 × 3½ ft.	4,116	"
Curbing, 6 ins. thick	3,430	"

The reservoir will cost $350,800. It is being done under the direction of three water commissioners: LOUIS P. REICHERT, President; JAMES RYAN, Secretary; and S. K. WORTHINGTON. Mr. LOUIS H. KNAPP, Chief Engineer and Superintendent of the water-works, is Constructing Engineer, with JOHN W. RECORD as Assistant Engineer. The late WILLIAM J. MCALPINE was Designing and Consulting Engineer. We are indebted to Mr. LOUIS H. KNAPP for the illustrations and accompanying data.



DETAILS OF NEW PROSPECT RESERVOIR: BUFFALO, N. Y.

The Zig-Zag Tunnel; New York, Ontario & Western Railway.

The New York, Ontario & Western Ry. Co. has under construction a tunnel and cut-off line to avoid the switchback known as the Zig-Zag at North Walton Summit, near North Walton, N. Y., between the Susquehanna River and the west branch of the Delaware. The "Zig-Zag," as well as the many high timber trestles, was one of the special features of the old Oswego Midland R. R., and, with its four inclined planes, its apex, its back-ups and back-downs, is about 3 miles long. The distance between the same points by the tunnel line is 5,300 ft., or about one mile. The maximum grades on each side of the

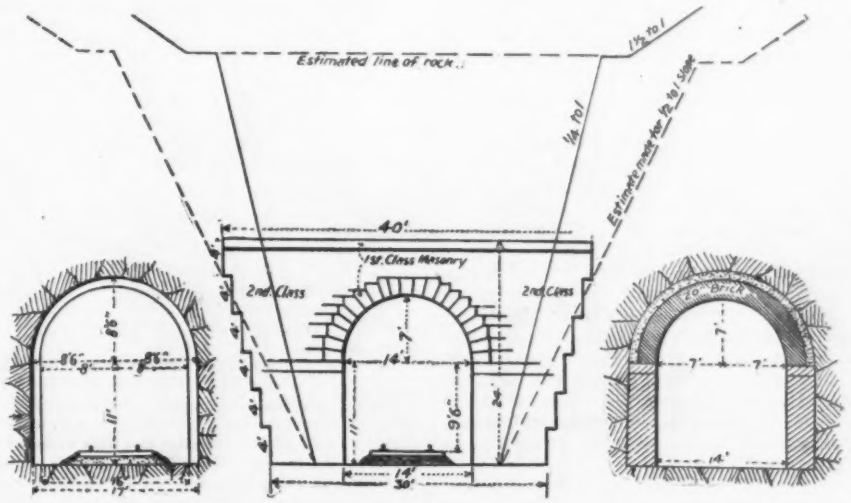
summit will be reduced from 104.54 ft. to 66 ft. per mile (1.98 to 1.25%) for south bound trains, and from 95.04 ft. to 39.6 ft. (1.8 to 0.75%) for north bound trains. The new line will obviate the necessity of pushing freight trains over the hill, which has cost the company at the rate of $30,000 per annum, or more than twice the interest on the estimated cost of the tunnel. The chief engineer's estimate was $279,000, but Mr. J. E. CHILDS, M. Am. Soc. C. E., the General Manager, says that they are satisfied that the cost of the work will be within this estimate. The work has been done under the direction of Mr. E. CANFIELD. M. Am. Soc. C. E., Chief Engineer; Mr. H. R. WHEELER, Assistant Engineer, in charge of the tunnel.

In June, 1889, a contract was let to Ward & Lary, of Newburg, N. Y., for the construction of the whole line, with the exception of the track. A slope was made at the north approach in May, 1890; the heading was started in June and completed on Dec. 23, 1890. The line will probably be ready for traffic by April, 1891. The work includes about 205,000 cu. yds. of earth and hardpan, and 40,000 cu. yds. rock excavation in the approaches, which materials have been used in filling 1,800 lin. ft. of timber trestles 25 to 60 ft. high and ½ to 6 miles distant on either side of the tunnel; 5,000 cu. yds. of masonry of all classes in tunnel portals, bench walls and arch culverts under the timber trestles, and 20,000 cu. yds. of excavation for the single-track tunnel, 1,627 ft. long. It was estimated that half of the tunnel, including the portals, would require arching or permanent support, but it is said that this item will probably be reduced to one-third. The excavation of the approaches and filling of trestles was necessarily slow, as the greater part of the material was hauled on cars during the hours when the single track was most occupied by the regular trains, and the trestles were not in condition for carrying on the work of filling at night.

Mr. CANFIELD states that no difficulties in construction have been encountered which are of special interest to engineers. Before the work was let the usual careful surveys were made and preliminary plans prepared, and some changes made in the original line. Seven test wells, the deepest being 151 ft., were drilled in the summit cut, on the center line and to the grade of the tunnel, to determine the character of materials to be excavated. The surface of the hill and for a depth of 15 to 40 ft. below the surface, is of earth, hard pan and boulders. Below the rock line a stratified sandstone was found, varying in color and hardness, but generally similar to the blue stone of the Midland quarries, known as the Catskill group of rocks, and intermingled with the shales and slates of the same formation. Samples of the drilling of each 3 ft. in depth for the lower 25 ft. of the test wells were preserved and marked for the information of contractors in making their proposals. The specifications required the heading to be made in the lower or rectangular part of the section and on the grade line of the tunnel, to avoid the heavy firing in the roof and to decrease the amount of arching. This requirement met with much opposition from the contractors at the time the bids were made, and a number of the bids named an additional price per cu. yd. for tunnel excavation, should this be enforced. The heading was commenced, however, in the bottom, the full width of the tunnel and from 8 to 10 ft. in height, and has been completed in the manner specified, with good progress, averaging 232 ft. for each month, working 20 hours per day. No temporary support or timbering has been required, and the cost of the heading to the contractors is stated to have been less than their price per cu. yd. for the full tunnel section. The progress made in October, November and December, 306 ft., 345 ft. and 290 ft., respectively, is believed by Mr. CANFIELD to be unusually good, if not the best, which has been made for a heading of these dimensions. The following table shows the progress made each month:

Month.	Size of heading. (Slope and heading.)	Excavation.
June		74 ft.
July		273 "
August	8 × 17 ft.	229 "
September	13 × 17 "	156 "
October	10 × 29 "	306 "
November	9 × 38 "	345 "
December	9 × 20 "	290 "

The tunnel is 1,627 ft. long, for a single track, with a down grade of 1.25% (66 ft. per mile) to the north. It is of the section shown in the accompanying illustration, having a flat floor, vertical sides and a semicircular roof. The normal section in rock, unlined, is 16 ft. wide, 11 ft. high to the springing line of the arch, and 16 ft. total height; the maximum section is 17 ft. wide, 11 ft. to the springing line and 19 ft. 6 ins. total height, no allowance being made for material excavated in excess of a ring 6 ins. wide outside of the normal section. The areas of the normal and maximum sections in rock are 276.53 and 300.49 sq. ft. respectively. On the lined parts of the tunnel the clear dimensions inside the lining are 14 ft. in width, 11 ft. in height to the springing line and 18 ft. total height. The brick arch was originally intended to be 24 ins. thick, with an area of 50.26 sq. ft. This was changed to 20 ins., which will be the probable average and will vary as may be found necessary; at some points 16 ins. will be sufficient. The side walls will be of stone, generally 3 ft. thick, with a belt or springing course of cut stone; the two walls contain 71.50 cu. ft. per ft. The rock excavation of the lined part is 377.07 cu. ft. per ft., allowing 6 ins. for packing above the arch. The portals are of plain design; the masonry is 40 ft. wide on top, 30 ft. wide at the level of the tunnel floor, and 24 ft. high above that level. The rock cuttings of approaches are 18 ft. wide at subgrade, with side slopes of ¼ horizontal to 1 vertical. The earth slopes above the rock are 1½ to 1.



THE ZIG-ZAG TUNNEL: N. Y., O. & W. RY.

The track will be laid with steel rails weighing 67 lbs. per yd.; they will have three tie supported joints, spliced by 36-in. steel angle bars and grip threaded bolts. There will be 18 ties to the rail length. The ballast will be of broken stone.

Electric Subways in Chicago.

A special committee of the Cincinnati Council was recently directed to examine the electric subways in Chicago with a view to the introduction of a similar system in Cincinnati. From the very full and complete description in their report, we make the following abstract:

On the burying of electric wires we would report that Chicago has been placing all wires under ground since May, 1883, and that the system is successful and entirely practical. All wires are placed underground, and various forms of conduits are used, all of them efficient for the purpose intended, and differing mainly on the score of relative cost. The city of Chicago has a conduit system constructed by itself. This system consists of nine lines of ordinary 3 in. iron pipes laid in three rows superimposed, and occupying a space of less than a square foot on the cross section. These 9 lines of pipe, buried some 5 ft. deep, are reached by manholes 4 ft. square and placed 250 or 300 ft. apart. The electric wires, singly or in cables, are run through these pipes, and at the manholes, connections are made for running single wires to adjacent property. The cost of this conduit system is not great. The manholes cost $100 to $125 each, and there are about twenty of them to the mile. That is, the manholes cost about $2,000 per mile. The additional cost of conduits per mile is easily calculated and is the cost for nine, twelve or any other number of lines of iron pipe, of the cheapest and lightest variety, and the placing of the same underground. Terracotta common sewer pipe and other forms of pipe may be used, but common iron pipes seem to be most satisfactory, as securing better jointing and exclusion of water. A large pipe of 9 ins. or more diameter may be substituted for the small pipes, but the larger pipe seems to require more expensive insulation of the wire placed therein. The estimated cost of 3-in. iron pipe is 10 cts. per foot, or 90 cts. per foot for a conduit of 9 pipes. In addition, 50 cts. per foot for laying same, making a total cost of about $7,500 per mile. Adding cost of manholes, the completed system of conduits should not cost more than $13,000 per mile. For a single 9 in. pipe the cost would be less. A fair rental for the use of one or more ducts of such a conduit would not be a heavy tax on any company using same. The city uses its own conduit for fire alarm, police, telegraph and electric lighting wires. Private companies use conduits of their own construction. The city of Chicago has 3 systems of electric lighting. The city itself owns a plant from which it operates some two thousand electric lights in a certain territory, at an estimated cost of $80 per lamp per annum. This is exclusive of any interest on the investment, and of course, exclusive of dividend paying, and represents approximately the actual running cost of operation. The Mayor of Chicago, from whom we obtained this information, could only give $80 as the approximate running cost, and did not have confidence in the accuracy of the figures. Another part of the Chicago territory is lighted by the city by contract at $165 per lamp per annum. Still other territory, more nearly suburban, is lighted by electricity by contract, the contracting company undertaking to light the territory satisfactorily at the cost of the gas and gasoline lamps displaced.

New York City in 1890.

From the last message of Mayor GRANT the following items of general interest can be abstracted: To commence with the bonded debt of the city of New York, on Dec. 31, 1890, was $146,371,022.88; an addition of about $5,000 000 in the year. Deducting amount held by Sinking Fund Commissioners and cash, the net debt is $98,064,413.07. The New Croton Aqueduct has so far cost the city $24,767,477.25, and the water was turned into the Central Park reservoir from the new supply on July 15, 1890, increasing the water supply to the city from 110,000,000 to 155,000,000 galls. daily. The now aqueduct was commenced in 1882, when the total supply was only 93,000,000 galls. per day. Mayor GRANT queries the wisdom of continuing the present Aqueduct Commission organization, and thinks that $150,000 per annum could be saved by turning all remaining work over to the Department of Public Works. He makes a similar remark regarding the commission for the Washington Bridge over the Harlem River. The bridge was finished a year ago, but the commission still costs the city $20,000 per annum.

Rapid transit, subways for pipes and wires and better street cleaning, are treated of and recommended on lines already familiar to the public. In reviewing the work of the departments the following items are given for work done in 1890: 86,500 ft. of water mains and 32,000 ft. of sewers laid; 300,000 ft. of sewers were cleaned. The revenue from Croton water is now about $3,000,000 per year. More than

700,000 sq. yds. of asphalt pavement were laid and 33¼ miles of streets were repaved. On May 1, 1889, there were but 3,000 sq. yds. of asphalt pavement in the city, whereas Mayor GRANT now claims that there is more of this pavement in New York than in London or in Paris. This is a startling statement that apparently needs some further explanation. The dock department is commended for good work done in extending piers and wharfage. The revenue from this department, for 1890, exceeded the cost of construction by $1,513,209.

The Board of Electrical Control, in charge of the underground disposal of telephone and telegraph wires and wires for electric light, report the construction of 178 miles of single duct, on 9 miles of streets. The total of telegraph and telephone subway is now 697 miles of ducts in 38 miles of street trench. For electric light wires there are 132 miles of ducts in 39 miles of street trench. In these subways there are now 10,150 miles of telegraph and telephone wires, and 340 miles of electric light wires. During the year 1,361 poles and 18,949,645 ft. of overhead wires were removed.

Live Loads and Weights of Bridges.

The diagrams on page 29 has been prepared for this journal by Mr. GEORGE H. PEGRAM, M. Am. Soc. C. E., to show graphically the different live loads for bridges which have become standard in the past 14 years, and the effect of these differences in live loads upon corresponding weights of the bridges.

The Decapod loading given is somewhat ideal in as much as the heavy train shown does not run on the roads now using the Decapod engines; but the fact that both engine and train loads exist is sufficient reason for combining them for a maximum loading.

No bridges had ever been built for this loading, to our knowledge, when the diagram was prepared, but since then the Erie has adopted a still heavier Decapod rolling load, with 161,000 lbs., instead of only 135,000 lbs. on the drivers; and even if still somewhat unusual the weights of bridges are none the less interesting as a mark toward which we are approaching, and to which, in our judgment, it would be better and more truly economical if we had already come.

A uniform load which shall be equivalent to the engine loading will vary with the length covered and will therefore be different for the stringers, floor beams, web members, and the chords of trusses. It is doubtful, however, how much of this apparent difference, which results from considering the static strains merely, is genuine; and in any case the *comparative* loads for different engines may be very well represented by the equivalent uniform loads *for chord stresses*, which are those shown in the diagram. The weights shown include all the iron about the structure.

The equivalent of the engine loading for all the spans, and therefore for all parts of a span, can be represented by a uniform load combined with a single concentrated load placed at that point in the uniform load, which will secure the maximum stress in the member considered, or which might be conceived to roll on the uniform load.

Such a loading was first submitted, we believe, in a discussion by Mr. PEGRAM of Mr. JOS. M. WILSON'S paper* as an equivalent for the maximum effects of the three types of loading then given in the Pennsylvania Railroad specifications. The equivalent load there given was arrived at by a tentative process to get an exact equivalent for all spans, observing the point at which the change is made from single to double web bracing, for it is apparent that for the same span a single concentrated load which would give proper strains in single system bracing would give excessive strains in the double bracing, because in reality the engine concentrations are divided between the systems, whereas we assume that the whole concentration is on *each* system. To be exact, we should assume a smaller concentration, say two-thirds, for the double system, but the difference is such a small percentage of the total strains that it seems proper for the sake of simplicity, to ignore it and use the single concentration in all cases.

The equivalent of the Decapod loading is a concentrated load of 30,000 lbs., combined with a uniformly distributed load of 36,000 lbs. per foot of track. This proves a little excessive for Decapod spans under 20 ft., as will be seen by the divergence from the regular curve shown by the dotted line in the diagram. The greatest excess is only about 12 per cent. at 15 ft. length of span and as there are other engines giving greater concentrations for short spans and also greater possible concentrated loads, such as cables for cable railways, heavy ordinance, etc., the curve seems a proper one throughout.

* Trans. Am. Soc. C. E., June, 1885.

The formulas for the weights of bridges for Mogul, Consolidation and Typical Consolidation and curves constructed from them, together with the data on which they are based, may be abstracted from Mr. PEGRAM'S paper as follows:

The weights of bridges of various spans were computed to be of first-class construction, without any additions of doubtful utility, so that while a bridge might weigh more than that given through some special excellence, it should not weigh much less. The following are the formulas deduced by Mr. PEGRAM, in all of which

S = the span, center to center, of bed-plates or end-pins, as the case may be.

W = the total or "shipping" weight of iron or steel in pounds.

For iron bridges under 200 ft. span:

$$(1)\quad W = \left(75 + \frac{S}{a}\right) S \text{ by } S,$$

in which
$a = 4.5$ for Class D.
$a = 7$ for Class T.
$a = 9$ for Class C.
$a = 12$ for Class M.

For iron bridges over 200 ft. span:

$$(2)\quad W = \left(5 + \frac{S}{b}\right) S^2$$

in which
$b = 100$ for Class C
$b = 80$ for Class T,
$b = 68$ for Class D.

For steel bridges over 300 ft. span:

$$(3)\quad W = cS^2,$$

in which
$c = 6$ for Class C. } Class D not determined; about 7.1.
$c = 6.7$ for Class T. }

The type of bridge assumed was as follows: For spans below 75 ft.: deck plate girder bridges, 8 ft. wide, connected with angle iron bracing, and with crossties resting on the top chords. Above 75 ft. up to 150 ft.: through truss bridges, Pratt or single quadrangular trusses. Over 150 ft.: Whipple or double quadrangular trusses.

The widths assumed were: For standard gage spans under 255 ft., 14 ft. in the clear; for 320-ft. span, 18 ft. center to center of trusses; for 420-ft. span 21 ft. center to center, and for 520-ft. span, 25 ft. center to center. The floors of the spans consisted of cross floor beams at the panel points, with a line of iron stringers under each rail, except for spans over 300 ft., which had three lines of stringers.

Differences in depth affect the weight less than would be supposed. Thus in a 60-ft. girder span, for Class T, the difference in total weights between depths of 5 ft. and 5½ ft. was practically nothing, and for an 80-ft. girder span, calculated for Class C, with depths of 6 ft., 6½ ft., and 7 ft., the difference was less than 1 per cent. In a 180-ft. truss span, the difference in weights between depths of 26 and 28 ft. was less than 2 per cent.

In a 520-ft. steel span, for Class T, the difference in weight between a depth of 50 ft., and one of 58 ft., was about 3 per cent.; a depth of 56 ft. was finally taken in this case.

Modifications for other conditions than those specified may be made as follows:

If wooden stringers are used, deduct 195 lbs. per ft. for Classes M and C, 210 lbs. for Class T. For safety stringers add 100 lbs. per ft. for all classes.

For deck-truss bridges add 10%, and for double-track bridges 90% to the formula weight.

Through plate-girder bridges will not differ materially from deck bridges in weight, where the crossties are made to serve as floor beams. When an iron stringer floor is used, it will be a close approximation to add 200 lbs. per ft. to the weight given by the formula.

For bridges of less than 150 ft. span, the only part of the rolling load which affects the weight of the bridge greatly is the engine load. For spans of over 200 or 250 ft., an average of the engine and car load per foot will come nearer to expressing the ratio by which the weight of the bridge is affected.

The weight of a drawbridge, including turntable, wheels and machinery to turn by hand, will be very nearly the same as for a fixed span of the same total length to carry the same live load. This rule is stated by Mr. PEGRAM to have been remarkably exact in tests on a number of drawbridges of 150 to 400 ft., both single and double track.

Formula D is new. The exactness of the formulas increases regularly from the Mogul to Decapod, which latter agrees exactly with the actual weights throughout. This is no doubt due to the greater uniformity of loading or to the less difference between the average weights of the engines and of the train.

How exactly the actual computed weights for various spans computed for the Decapod loading agrees with the approximate formula from which the diagram is constructed may be seen from the following table:

		Actual.		Formula.
20	ft.	7,495	lbs.	7,098
30	"	13,787	"	13,431
50	"	31,150	"	30,436
150	"	199,263	"	199,001
201½	"	344,146	"	343,356
255	"	570,000	"	566,200 by formula 1 568,980 by formula 2

Formula 1 is not supposed to run correctly above 200 ft. spans, but we add what it would give for a 255 ft. span, to indicate how much it falls short.

The weights given are for two lines of iron stringers, as explained. The weight of the deck (ties, guards and rails), will be 350 lbs. per ft. for all spans, which, added to the weights given, will give the total dead loads. The curves have been constructed from the formulas by points at every 10 ft. The actual weights upon which the formulas are founded for classes M, C and T are given in Trans. Am. Soc. C. E. for February, 1886. The computed weights are shown in the following table:

COMPUTED WEIGHTS FOR BRIDGE SPANS.
(From which the diagram was constructed.)

Span	Mogul.	Consolidation.	Typ. Consolidation.	Decapod.
20	6.856	6 901	6.960	7.098
30	12.741	12.872	13.036	1 .431
40	19.794	20.072	20.403	21 210
50	27.907	28.456	29.022	30.436
60	37.200	37.944	38.874	41.060
70	47.348	48.462	49.810	53.083
80	58.431	60.005	61.793	66.371
90	70.463	72.598	74.990	81.139
100	83.300	86.100	89.300	97 2.0
110	97.251	100.700	105.105	113.710
120	112.200	116.556	121.572	134.112
130	127.100	132.580	138.850	153.980
140	143.228	149.506	156.940	175.277
150	160 781	168.315	177.190	199.001
160	178.719	187.625	198.150	223.652
170	197.738	208.379	2?6.148	250 078
180	217.440	229.529	242.850	277.840
190	238.077	251.974	267 706	306.298
200	259.328	274.882	292.981	357.663

We have deduced certain further facts from the above figures, and discussed somewhat the moral to be drawn from them, in another column.

Experiments on the Permeability of Brick.

BY A. W. HALE, ASSISTANT ENGINEER NEW CROTON AQUEDUCT.

(*Concluded from page 20.*)

Results and Conclusions.—1. The method adopted is to be trusted; whatever errors there may be in the results (with the exception of a possible constant error in the graduation of the pressure gage and measuring vessel) being accidental, due to a variation in the amount of foreign substances in the water, the presence of air in the pump flask or brick, sudden changes in the structure of the specimen, through the breaking down of obstructions and the choking up of passages, variations in pressure and lubrication of the plunger, errors of observation, etc., the amount and effect of which are, in the majority of instances, indicated by the probable error.

The integrity of the apparatus is shown by the fact that when a block of iron was substituted for a brick, under a pressure of 200 lbs. per sq. in., no water escaped.

2. The percolation through the brand of brick tested, (viz. Croton common, anchor brand), is copious and varies widely in different specimens; under a pressure of 80 lbs. per sq. in., the percolation through a brick 2⅝ ins. thick, in cubic inches per square inch per hour, being: Maximum, 40.44; minimum, 4.02; average, 12.3.

3. The percolation through a brick under a constant pressure diminishes as the pressure is prolonged.

4. The diminution of the percolation under a constant pressure is less and less rapid as the flow is continued, and finally becomes constant.

5. From data furnished by the experiments the constant, corresponding to an observed inconstant, percolation may be determined, and is, in fact,

three-fifths of the variable percolation with a probable error of 7.6%.

6. The percolation increases with the pressure more rapidly than theory would indicate.

This conclusion is sustained by the results of experiments with lime of Teil obtained by the Chief Engineer of the Aqueduct Commission from Roanne in France, by which it appears that the observed percolation averages 4.7% higher than that calculated from the observed percolation under the preceding lower pressure.

7. The percolation through a brick, under pressures ranging from 30 to 80 lbs. per sq. in., ranges from 3.66 to 6.6 cu. in. per sq. in. per hour.

8. The temperature of the escaping water, which is higher than that of the feed water, indicates that a considerable percentage of the force expended is consumed in heating the water, and, therefore, that the observed percolation is less than if there were no such rise of temperature.

9. The percentage of force thus converted into heat, and the corresponding reduction of the percolation necessarily increase as the permeability of a brick is, by coating or otherwise, diminished.

10. The presence of impurities and of air in the water tends to render the percolation inconstant. The tabulated results of two sets of experiments made with the same brick showing that the precision of the results was 138% greater when the water was boiled than when it was not.

11. At a pressure of about 80 lbs. per sq. in., boiled water is driven through a brick by the same force, at a pressure as marked by gage 11% lower than

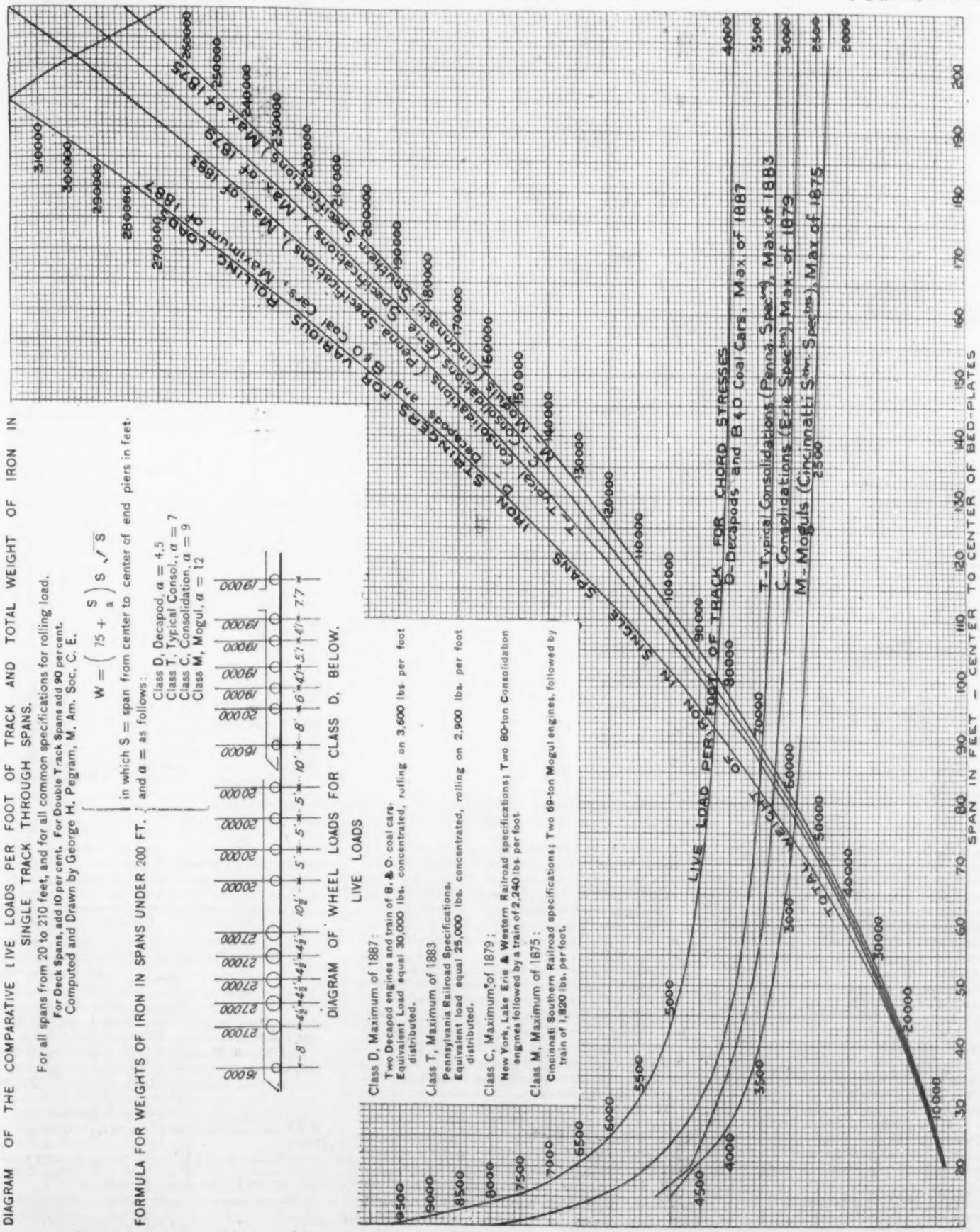


DIAGRAM OF THE COMPARATIVE LIVE LOADS PER FOOT OF TRACK AND TOTAL WEIGHT OF IRON IN SINGLE TRACK THROUGH SPANS.
For all spans from 20 to 210 feet, and for all common specifications for rolling load.
For Deck Spans, add 10 per cent. For Double Track Spans add 90 per cent.
Computed and Drawn by George H. Pegram, M. Am. Soc. C. E.
FORMULA FOR WEIGHTS OF IRON IN SPANS UNDER 200 FT.
W = (75 + S/a) S √S
in which S = span from center to center of end piers in feet.
and a = as follows:
Class D, Decapod, a = 4.5
Class T, Typical Consol., a = 7
Class C, Consolidation, a = 9
Class M, Mogul, a = 12
DIAGRAM OF WHEEL LOADS FOR CLASS D, BELOW.
LIVE LOADS
Class D, Maximum of 1887:
Two Decapod engines and train of B. & O. coal cars.
Equivalent Load equal 30,000 lbs. concentrated, rolling on 3,600 lbs. per foot distributed.
Class T, Maximum of 1883
Pennsylvania Railroad Specifications.
Equivalent load equal 25,000 lbs. concentrated, rolling on 2,900 lbs. per foot distributed.
Class C, Maximum of 1879;
New York, Lake Erie & Western Railroad specifications; Two 80-ton Consolidation engines followed by a train of 2,240 lbs. per foot.
Class M, Maximum of 1875:
Cincinnati Southern Railroad specifications; Two 69-ton Mogul engines, followed by train of 1,820 lbs. per foot.
STRAINS FOR VARIOUS LOADS and B & O Coal Cars.
Max. of 1887
Max. of 1883
Max. of 1879
Maximum of 1875
Decapods (Penna. Specs.)
Consolidations (Cincinnati Southern Specifications)
Consolidations (Penna. Specifications)
Consolidations (Erie Specs.)
Moguls (Cincinnati Southern Specs.)
LIVE LOAD PER LINEAL FOOT OF TRACK FOR CHORD STRESSES
D-Decapods and B & O Coal Cars, Max. of 1887
T-Typical Consolidations (Penna. Specs.), Max. of 1883
C-Consolidations (Erie Specs.), Max. of 1879
M-Moguls (Cincinnati Southern Specs.), Max. of 1875
SPANS IN FEET - CENTER TO CENTER OF BED-PLATES

that indicated, when the water is drawn directly from the hydrant.

12. The percolation through a brick perpendicular to the bed differs widely in opposite directions, the difference being, Maximum, 147.4%; minimum, 0.7%; average, 31.1%.

13. The percolation is uniformly greater from the top toward the bed; that is, with the pressure against the surface not coated with the sand which adheres to the bed of the brick when taken from the mold.

14. The percolation through a brick conduit 12¼ ft. bore, and with from 2 to 6 rings of common Croton brick, without cement, and assumed to be without joints perpendicular to the axis of the conduit, under a pressure of 30 lbs. per sq. in., ranges in million gallons per mile per diem, from 6.24 to 9.14; average, 7.36.

The variation in the percolation for different pressures and thicknesses of lining is shown in the Table 2.

TABLE 2.

PERCOLATION THROUGH A BRICK CONDUIT.

Without cement and without joints perpendicular to axis.

Length of conduit, 1 mile; inner diameter, 12¼ ft.; thickness of rings of brick, 3⅛ ins.; brick, common Croton.

No. of rings.	Percolation in million gallons per day, with pressures per square inch of — 10 lbs.	20 lbs.	30 lbs.	40 lbs.	50 lbs.
2	5.40	7.46	9.14	10.55	11 80
3	4.51	6.37	7.80	9.01	10.07
4	4.07	5.76	7.05	8.14	9.10
5	3.79	5.36	6.57	7.59	8.48
6	3.60	5.09	6.24	7.20	8.05

The calculations are made for a brick tube without cement and without joints perpendicular to the axis of the conduit, for the reason (see § 15) that trustworthy data with respect to percolation through brick and cement are lacking.

Table 2, calculated from the results of experiments, by means of the formulas of hydraulics, is only approximately correct, since the calculated percolation under different pressures is less, (see § 6,) than that determined by experiment; and since the formulas do not take into account the variation produced by an increase of thickness of wall, (see § 8 and 9), in the amount of energy dissipated as heat.

15. The estimated percolation through the walls of a conduit, 12¼ ft. bore, of common Croton brick, laid in neat cement, with a thickness of wall from 8 to 24 ins. under a pressure of 30 lbs. per sq. in., ranges in gallons per mile per diem from 72,964 to 106,936; average 86,105.

The above calculated result, based upon experiment and accepted formulas, is not consistent with other experimental results obtained; the percolation, therefore, through brick and mortar can be determined definitely only by direct experiment.

16. The percolation is largely diminished if the water be made turbid with clay; the average diminution under pressures ranging from 30 to 80 lbs. per sq. in. being 52.1%.

17. The effect of an infusion of clay in diminishing the percolation increases the pressure.

18. When clear water is afterward substituted for turbid water, the percolation, under a pressure of 80 lbs. per sq. in. is still diminished 35.6%.

19. After the clay has been partially washed out by a flow in the opposite direction under pressure and the direction of flow again reversed, the percolation of clear water is still diminished 15.3%, under a pressure of 80 lbs., 48.2% under a pressure of 40 lbs. per sq. in.

20. The percolation through neat cement brick, made of different brands of cement, selected as typical, varies widely, (200%), in the samples tested, 2½ ins. thick under a pressure of 80 lbs. per sq. in.; the percolation in cubic inches per square inch per hour being: Maximum, 0.0054; minimum, 0.0018; average, 0.0035.

These specimens of cement brick were tested after setting under water about 13 months. They were made from selected barrels of cement, the basis of selection, determined by duplicate tests made at the offices of two Divisions, being conformity to the average of the tests made on the line of the Aqueduct up to date, the number of which for the respective brands is given in Table 3.

Eighty of these tests were required before sample barrels (of the 5 brands of cement selected) conforming to the specifications, based upon average results, were obtained.

TABLE 3.

NUMBER OF BARRELS TESTED.

From the several brands enumerated, made on the line of the new Croton aqueduct prior to April 8, 1888:

Brand.	Number of tests. Days. 1.	7.
F. O. Norton-Rosendale	3,884	1.618
New York & Rosendale Bridge Brand	296	115
Akron Obelisk	6,097	2,937
Portland	1,519	2,929
Total	11,796	7,599
"	19,395	

The specifications for the selection of sample barrels of cement based upon the records of the above tests, is given in Table 4.

TABLE 4.

SPECIFICATIONS FOR TESTING CEMENT.

Based upon average results of tests. Table 3.

Brand.	Maximum. Fineness. Percent. retained by sieve; Meshes per sq. in. 7,500	10,000	Setting. Minutes required to sustain heavy wire.	Minimum tensile strength lbs. per sq. in. Days. 1	7
F. O. Norton-Rosendale	7	18	60	70	95
N. Y. & Rosendale Bridge Brand	7	18	20	85	115
Akron Obelisk					
Burge & Barron, English Portland	7	14	90	130	300
Alsen's German Portland					

TABLE 1. SHOWING THE PERCOLATION THROUGH BRICK, COATED AND UNCOATED.

No.	Specimen. Description.	Brick. No.	Thickness.	Area. Sq. in.	Coating. No.	Spec. gravity.	No. coats applied.	Feed water. Croton.	Temp. water.	Pressure. Against.	Lbs. per sq. in.	No. observations.	Percolation. Cu. ins. per sq. in. per min.	Prob. error of a obs. Per cent.
1	Brick, common Croton	5	2⅜	16.25				Boiled, filtered through brick.	60	Top.	150	1	1.502	...
2	" " "	5	"	16.25					60	"	80	1	0.888	...
3	" " "	5	"	16.25					76	Bed.	"	4	0.236	...
4	" " "	17	"	16.00				Boiled	73	Top.	"	1	0.651	...
5	" " "	17	"	16.00					76	Bed.	"	3	0.261	..
6	" " "	28	"	16.25					66	Top.	"	1	0.464	....
7	" " "	28	"	16.25					65	Bed.	"	12	0.403	5 51
8	" " "	5	"	16.25				From tank.	61	"	"	21	0.219	4.03
9	" " "	5	"	16.25				Boiled, filtered.	76	"	"	20	0.206	1.73
10	" " "	17	"	16.00				Boiled.	74	"	"	11	0.197	3.65
11	" " "	36	"	17.63				"	69	"	"	14	0.067	4.88
12	" " "	37	"	17.20				"	71	"	"	18	0.18	2.60
13	" " "	37	"	17.20				Boiled, filtered through paper.	74	"	"	13	0.11	0.73
14	" " "	63	"	17.02					58	"	"	13	0.674	4.35
15	Cement-brick, Akron	73	2½	17.76				"	64	"	"	12	0.00076	1.16
16	" " Alsen	113	"	17.80				"	65	"	"	13	0.00030	3.05
17	" " "	113	"	16.64				"	64	Top.	"	13	0.00096	2.79
18	" " Norton	110	"	17.35				"	62	Bed.	"	11	0.00079	0.94
19	" " "	110	"	15.59				"	53	Top.	"	11	0.00048	0.72
20	" " Burge & Baron	111	"	17.51				"	65	Bed.	"	12	0.00073	1.82
21	" " "	111	"	16.00				"	48	Top.	"	12	0.00091	1.00
22	Brick, Anchor Croton	37	2⅜	17.20				"	75	Bed.	30	13	0.061	2.95
23	" " "	"	"	17.20				"	73	"	40	13	0.057	0.94
24	" " "	"	"	17.20				"	76	"	50	13	0 076	0.5
25	" " "	"	"	17.20				"	76	"	60	13	0.09	0.52
26	" " "	"	"	17 20				"	76	"	70	13	0.108	0.56
27	" " "	"	"	17.20				"	74	"	80	13	0.11	0.73
28	" " "	"	"	17.20	5			Boiled, saturated with clay.	76	"	30	11	0.032	0.59
29	" " "	"	"	17.20	6				76	"	40	13	0.0346	0.55
30	" " "	"	"	17.20	7				75	"	50	13	0.035	0.34
31	" " "	"	"	17.20	10				70	"	60	11	0.033	0.46
32	" " "	"	"	17.20	11				72	"	70	13	0.03	0.56
33	" " "	"	"	17.20	12				74	"	80	12	0.029	0.25
34	" " "	"	"	17.20	4			From hydrant.	76	"	80	13	0.06	0.96
35	" Croton, twice reversed	"	"	17.20	3			"	77	"	80	12	0.09	2.85
36	" " "	"	"	17.20	9			"	78	"	40	13	0.04	0.68
37	Prop'y compound A	17	"	16.00	2	1.429	2	Boiled, filtered through paper.	60	"	80	12	0.117	1.71
38	" " Ca	46	"	17.06	8a		1		65	"	"			
39	" " Cb	46	"	17.06	8b		1		65	"	"			
40	" " C	46	"	17.06	8				65	"	"	13	0.045	1.18
41	" " B	5	"	16.25	13	1.128	2		69	"	"	20	0.0132	2.54
42	Calcium chloride	37	"	17.20	14a	1.226	2		72	"	"	12		
43	Water glass	37	"	17.20	14b	1.358	2		72	"	"	12	0.0123	0.63
44	Prop'y compound Ca	46	"	17.06	15a		2		48	"	"			
45	" " Cb	46	"	17.06	15b		2		48	"	"			
46	" " C	46	"	17.06	15				48	"	"	12	0.0058	2.58
47	" " M	63	"	17.02	16	1.018	2		60	"	"	13	0.0052	0.51
48	Alsen's German Portland	45	"	17 13	18		1			"	"	12	0.0026	0.47
49	Prop'y compound D	35	"	17.70	20	0.882	2	Boiled	73	"	"	14	0.0016	2.05
50	" " E	36	"	17.70	21	0.827	2	Boiled, filtered through paper.	67	"	"	16	0.0012	0.62
51	Alsen's German Portland	44	"	17.47	23		2		78	"	"	12	0.00115	1.80
52	Prop'y compound F	32	"	17.71	24	0.889	2	Boiled.	65	"	"	11	0.0009	1.79
53	Alsen's German Portland	44	"	17.47	26		3	Boiled, filtered through paper.	78	"	"	10	0.00089	1.41
54	Prop'y compound G	28	"	16.25	27	0.949	2	Boiled.	65	"	"	10 hrs	0.0	0.0
55	Alsen's German Portland	44	"	17.47	28		4	Boiled, filtered through paper.	....	"	"	20 hrs	0.0	0.0
56	" " "	44	"	17.47	28		4		...	"	160	1 hr.	0.0	0.0
57	Sylvester's castile soap	48	"	28.00	29a	1.010	4		..	"				
58	" alum	48	"	28.00	29b	1.008	4			"				
59	Prop'y compound H	49	"	28.00	30	1.300	2			"				
60	" " I	55	"	28.00	31	1.292	2			"				
61	Linseed oil varnish	60	"	28 00	32	0.930	2			"				
62	Aluminum binacetate	68	"	28.00	35	1.027	2			"				
63	Prop'y compound J	56	"	28.00	36	0.852	2			"				

Amount of coating applied per sq. yd. Gals. or lbs.	No. of coats. 1	2	3	4	Total.	Price per gal. or lb. $	Cost per sq. yd. $	Time allowed for setting coat. 1 D. H.	2 D. H.
Gals.					0.072	0.55	0.039	0 17	.....
Lbs.	0.892	.....	.....	.....	0.892	0.02	0.018	24 23	.....
"	0.957	.....	.....	.....	0.957	0.02	0.019	24 23	.....
"	1.849	.....	.....	.....	1.849	.....	0.037	24 23	.....
Gals.	0.089	0.044	.....	.....	0.133	0 85	0.1131	0 4	0 21
"	0.032	0.021	.....	.....	0.054	.....	.....	0 5	0 7
"	0.032	0.032	.....	.....	0.063	.....	.....	1 18	12 18
Lbs.	0.892	0.603	.....	.....	1.494	0.02	0.03	24 23	3 17
"	0.957	0.509	.....	.....	1.466	0.02	0.029	24 23	3 17
"	1.849	1.112	.....	.....	2.960	.....	0.059	24 23	3 17
Gals.	0.091	0.081	.....	.....	0.172	.....	.....	12 00	11 0
Lbs.	0.228	.....	.....	.....	0 228	0.00625	0 0014	200 0	.....
Gals.	0.067	0.063	.....	.....	0.13	1.00	0.13	2 18	2 0
"	0.0784	0.0821	.....	.....	0.1605	0.75	0.1204	0 20	1 23
Lbs.	0.636	0.67	.....	.....	1.306	0.00625	0.0082	8 18	59 4
Gals.	0.151	0.054	.....	.....	0.208	1.00	0.208	3 17	4 0
Lbs.	0.636	0.67	0.746	.....	2.052	0.00625	0.0128	8 18	59 4
Gals.	0.062	0.065	.....	.....	0.172	.....	.....	1 1	3 21
"	0.636	0.67	0.746	1.129	3.181	0.00625	0.02	8 18	59 4
"	0.636	0.67	0.746	1.129	3.181	0.00625	0.02	8 18	59 4
"	0.484	0.0479	0.0502	0.1116	0.6937	0.12	0.0832	4 0	1 19
"	0.0652	0.0202	0.0419	0.0475	0.1745	0.025	0.0044	20 0	2 2
Gals.	0.067	0.037	.....	.....	0.104	.....	.....	27 1	30+
"	0.047	0.032	.....	.....	0.079	.....	.....	37 23	30+
"	0.066	0.048	.....	.....	0.114	.....	.....	7 9	30+
"	0.176	0.081	.....	.....	0.257	.....	.....	8 0	30+
"	0.062	0.08	.....	.....	0.142	0.75	0.1065	4 0	7 2

NOTE.—Nos. 37-41, 44-47, 49, 50, 52, 54, 59 and 63 are proprietary compounds, containing unknown ingredients.

21. The time required to saturate these samples of real cement brick under pressure varied from 7 hours to 5 days.

22. The rate of percolation *after* saturation appears to be independent of the time required *for* saturation.

These last two results agree, generally, with the results of experiments of a similar character made with cement of La Porte de France at the dam of La Tache, near Roanne.

23. The difference in the percolation through a neat cement brick in opposite directions is considerable, maximum being 223.6%, minimum 24.3%, the average 78.7%.

24. The maximum percolation through a cement brick is not, as in the case of common brick, invariably in the same direction.

25. The number of tests of cement-brick thus far made is not sufficient to determine the relative permeability of different brands; shown by the fact that the average difference in the percolation in opposite directions through the same brick is 17% greater than the average difference through brick of different brands.

26. Considerations, both theoretical and experimental, and quite apart from the tests made with the several compounds submitted, lead to the conclusion that a very considerable diminution of percolation is to be looked for, from the application of even an inferior coating; thus making the question of relative durability the one of first importance, rather than that of relative permeability.

Theoretically, and approximately, the addition of a second coat will reduce the percolation 67% more than the addition of a second brick. Experimentally, the difference is much greater.

The relative theoretical percolation through walls of different thickness is shown by Table 5.

TABLE 5.

RELATIVE THEORETICAL PERCOLATION THROUGH VERTICAL WALLS AND CYLINDERS OF VARYING THICKNESS.

Vertical wall.			Cylinder 12¼ ft. bore.		
Brick.	Percolation.	Dif.	Rings.	Percolation.	Dif.
1	100	..	1	100	..
2	71	29	2	74	26
3	58	13	3	63	11
4	50	8	4	57	6
5	45	5	5	53	4
6	41	4	6	51	2
Total, 3 to 6 brick		30			23

From this table it appears that the total reduction of percolation produced by the addition of a third, fourth, fifth and sixth brick is, in the case of a vertical wall only 3.44% greater, and is in the case of a cylinder, 12¼ ft. in diameter, 12.54% less than that produced by the addition of a second brick.

Experimentally the least effective coating tried reduced by the percolation through a brick 2⅝ ins. thick, under a pressure of 80 lbs. per sq. in., 4.1%.

Under these conditions of pressure and thickness, simply reversing a brick, so as to take advantage of the natural sand coating, which is 42% less efficient than the poorest coating tried, diminishes the percolation 24%.

Hence even an inferior coating may be expected to produce a marked effect on the permeability of a brick conduit.

27. The durability and permanent impermeability of the various coatings applied to brick, can be determined only after the lapse of considerable time, a number of the coatings tried having been found, after long exposure, to have changed in their chemical constitution and to have deteriorated. For the purpose of obtaining some information with respect to the effect of long exposure, a number of coats of various solutions were applied at intervals to a core, and suspended in the air. The results of these experiments are collected in table 6.

The several coatings tried show a range of diminution of percolation, after the application of two coats from a minimum 13%, to a maximum 100%, averaging 87.2%.

TABLE 6—EFFECT OF LONG EXPOSURE ON COATINGS.

Coating.	No. of coats.	Description.	Time setting. Each coat. (Approx.) Days.	Total. Months.	Total. Days.	Lustre.	Hardness.	Remarks.
2	3	Compound* A	30	6	28	Dull	Soft	Easily indented.
13	4	Compound* B	14	6	28	Bright.	Soft	Sticky
14a	7	Calcium chloride and water glass	1	10	6	Dull	Hard	After exposure for several months coating fell off
14b	8							
14b	10	Water glass	1	4	0	Dull	Hard	Chemical change occurred, leaving a hard, firm coating of gelatinous silica or carbonate of soda.
14b	13	Water glass		10	9			After an exposure of six months coating fell off.
15a-b	2	Compound* C	2	3	27	Dull	Very hard	Firm.
18	7	Cement wash	7	6	25	Dull	Hard and firm / Soft and loose	When applied with a brush. When applied by sifting.
20	6	Compound * D	3	6	26	Very bright.	Hard	Not easily indented.
21	8	Compound * E	7	6	26	Very bright.	Hard	Not easily indented. Coating very thick.
24	4	Compound * F	14	6	25	Bright.	Moderately hard.	
27	4	Compound * G	7	6	26	Bright.	Easily indented.	After some months' exposure peeled off from brick.
29a-b	9	"Sylvester's" or "Dearborn's" Castile soap and alum	4	6	22	Dull	Very soft	Sticky when applied to brick; after long exposure efflo-resced and exfoliated.
30	3	Compound * H	20	6	26	Dull	Soft	
31	2	Compound * I	30	6	26	Dull	Easily indented.	
32	3	Linseed oil varnish	14	6	25	Very bright.	Not very easily indented	Thin; transparent.
35	2	Aluminum binacetate	8	3	2	Dull	Soft	When applied to brick, efflo resced.
36	4	Compound * J	20	6	25	Very bright.	Not easily indented.	
37		Compound * K						Solution set in bulk.
38	5	Cement and water glass	7	6	9	Dull	Hard	After long exposure coating fell off.
39	2	Compound* L	20	6	0	Dull	Soft	After long exposure coating fell off.
40	6	Iron varnish	7	6	19	Bright.	Not easily indented.	
41	7	Shellac varnish	7	6	25	Bright.	Easily indented.	

* Proprietary compounds, ingredients unknown.

The data upon which the above conclusion is based, calculated from the data furnished by the experiments upon a single brick under varying circumstances, are collected in Table 7.

TABLE 7.

PERCOLATION THROUGH A COATED BRICK CONDUIT WITHOUT CEMENT AND WITHOUT JOINTS PERPENDICULAR TO ITS AXIS.

Length of conduit, 1 mile; inner diameter of conduit, 12¼ ft.; number of rings of brick, 2; thickness of rings, 3⅛ ins.; brick, common Croton; pressure, lbs. per sq. in., 30.

No.	Coating. No.	Coats. No.	Descripton of Coating.	Mil. galls. per mile per diem.	Prob. error %	Reduced by coating %
1	0	....	Natural sand on brick bed	9.14	10.32	.....
2	1	1	Sand on bed and top of brick	8.95	9.93	2.07
3	2	2	Compound* A	7.95	7	12.99
4	....	....	3 rings of brick	7.80	10.32	14.64
5	3	....	Clay, washed out with 80 lbs. pres're	7.74	7.60	15.29
6	...	....	4 rings	7.05	10.32	22.86
7	....	....	5 "	6.57	10.32	28.13
8	....	..	6 "	6.24	10.32	31.77
9	4	....	Clay, 80 lbs., water clear	5.88	4.34	35.63
10	5	....	Clay, 30 lbs., water turbid	5.51	3.90	39.33
11	6	....	Clay, 40 lbs., water turbid	5.52	3.81	39.66
12	7	....	Clay, 50 lbs., water turbid	4.73	2.79	48.23
13	8	1	Compound* C	4.46	2.65	51.21
14	9	...	Clay, w'sh'd o't, 40 lb	4.24	2.3	53.61
15	10	....	Clay, 60 lbs., water turbid	4.09	2.11	55.23
16	11	....	Clay, 70 lbs., water turbid	3.50	1.60	61.75
17	12	...	Clay, 80 lbs., water turbid	3.09	1.21	66.16
18	13	2	Compound* B	1.46	2.50	84.03
19	14	2	Water glass	1.37	0.67	85.03
20	15	2	Compound* C	0.65	2.57	92.88
21	16	2	" N	0.58	5.08	93.64
22	17	1	Cement, plaster 0.127 in. thick	0.286	15.87	96.868
23	18	1	Cement wash	0.2863	0.47	96.868
24	19	2	Cement and Pat. C.	0.2859	3.64	96.873
25	20	2	Compound* D	0.18	2.07	98.43
26	21	2	" E	0.14	9.94	98.52
27	22	1	Cement plaster 0.63 ins. thick	0.13	16.24	98.59
28	23	2	Cement wash	0.13	1.80	98.59
29	24	2	Compound* F	0.10196	1.79	98.88
30	25	3	Cement plaster 1.05 ins. thick	0.09985	16.09	98.91
31	26	3	Cement wash	0.09985	1.41	98.91
32	27	2	Compound* G	0.0	0.0	100.00
33	28	4	Cement wash	0.0	0.0	100.00

* Proprietory compounds, ingredients unknown.

The results given in this table are reduced to the percolation per mile of conduit, for the purpose of obtaining a tangible and significant basis for the comparison of the effect of the several coatings.

The relation between these results and those given in Table 1 are not simple, direct, or easily recognized, since they involve numerous changes in the conditions, the average variable percolation in cubic centimeters per square inch per minute under various pressures, through a brick 2⅝ ins. thick, with one sand coating, and representing a portion of a vertical wall, being reduced to the constant percolation, (§ 5), under a pressure of 30 lbs. per sq. in., in gallons per mile per diem, through a cylinder 12¼ ft. in diameter, composed of two rings of brick 3⅛ ins. thick, with a sand coating on both edges, and with the several coatings added.

The probable error is adjusted to these changes of condition.

The results given in Table 7 are calculated for a brick tube without cement and without joints perpendicular to the axis of the conduit, for the reason (§ 15), that trustworthy data with respect to percolation through brick and cement are lacking.

They serve their purpose nevertheless as a basis for comparison of the relative efficiency of the several coatings.

If the brick were assumed to be laid with perfect cement joints the percolation would be less, if the joints were imperfect, the percolation might be greater than that given in the table.

It may be assumed, also, that the percolation given is greater than would occur in practice, under the same conditions for the higher, and less for the lower rates of flow.

Owing to the extreme slowness with which No. 3 coating, 2 in Table 7, sets, it is probable that the diminution of percolation given in the last column falls short of what it would be, if sufficient time could be allowed for drying.

Rejecting this result as doubtful, and also the results obtained with turbid water, it appears that the least efficient coating tried reduces the percolation through a brick conduit 12¼ ft. in diameter under a pressure of 30 lbs. per sq. in., 51%.

29. The cost of the material required for the application of two coats of 12 of the compounds, for which prices have been quoted, ranges per mile of conduit 12¼ ft. in diameter as follows:

Minimum, coating 23—Alsen's German Portland cement, $184; minimum, excluding cement, coating 2—compound A, $894; maximum, coating 24—compound F, $4,699; average, $2,109.

Whence it appears that the cheapest material for which a price has been quoted costs 386% more than the best Portland cement.

30. With the addition of successive coats of cement the percolation diminishes much more rapidly than the cost increases.

The relation of percolation to cost of cement, no allowance being made for waste of material, is shown by table 8.

TABLE 8.

RELATION OF COST TO PERMEABILITY OF SUCCESSIVE COATS OF CEMENT.

No. coats.	Percolation per mile per diem. Galls.	Cost per mile. $
1	286,303	*32
2	125,718	184
3	99,851	290
4	0	449

* The relatively low cost of the first coat above given is due to the fact that it was exceptionally thin.

31. The relative impermeability of Portland cement is high, and after setting 6 months it shows a gain in impermeability which is then as high as that of any coating tested.

32. A coating of Portland cement also shows a gain in impermeability, under a water pressure of 80 lbs. per. sq. in., maintained for 2 months.

33. The deterioration of some of the coatings tested, after long exposure; the absence of evidence with respect to the others, with the exception of hydraulic cement, that they will not deteriorate; the fact that hydraulic cement is known to increase in strength with age; the fact that it has been found in these experiments to improve under a high water pressure, and its relative efficiency, availability and moderate cost, seem to reduce the questions to be considered to the selection of the proper brand of cement, method of application, and protection from abrasion and wear.

34. The permeability of a brick diminishes much more rapidly when coated with successive washes of cement than when coated with an increased thickness of cement plaster applied with a trowel, the ratio being as follows:

Washes.		Thickness of plaster.
1	to	1
2	"	5
3	"	8

See table 7, Nos. 22 and 23, 27 and 28, 30 and 31.

This somewhat surprising result may find explanation in the fact that the wash penetrates the surface of the brick more freely than the plaster; that the coating applied with a brush is less porous than that applied with a trowel, and also in the fact, indicated in §26, that impermeability depends more upon the integrity of the coating than upon its thickness.

35. After many experiments with respect to the application of a coating of cement, the best results were obtained by applying moistened, finely ground cement with a moderately soft brush.

36. In the absence of evidence with respect to the effect which the several compounds tested might have upon the setting of cement, coating 15, proprietary compound C, Table 6, a quick-setting, somewhat porous, and very hard hydraulic cement, is the only one of the materials submitted that can be *safely* recommended as a protection to a coating of Portland cement.

The addition, however, of coating 15, while it diminishes the percolation 0.16% only, increases the cost of material 559%; whence the advantage to be gained by such an application is confined, practically, to an increase in durability, but at a greatly increased outlay.

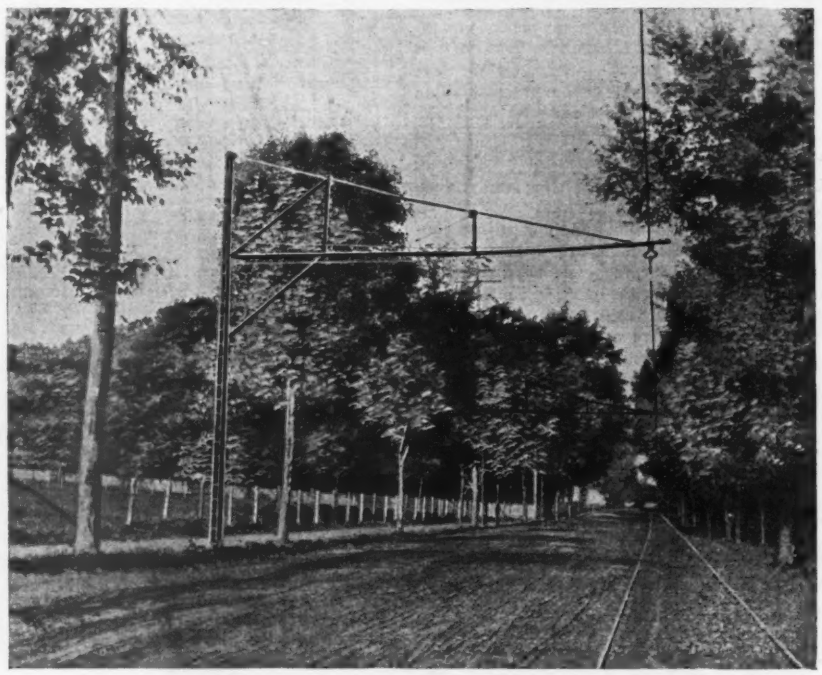
37. The results of these experiments indicate that one or more coats of fine Portland cement applied with a brush may be expected to very largely increase the tightness of a brick conduit, and at a minimum of cost.

The Largest Electrical Street Railway Pole.

The illustration given herewith shows what is claimed to be the largest electrical street railway pole as yet erected. There are four of these poles on the Passaic, Clifton & Garfield Street railway in Passaic, N. J. This road runs its tracks on one side of the street, but at a certain point the objection of property owners to poles located on their curb line made some other type of support for the wires necessary. The only feasible plan was to put the poles on the opposite side of the street and carry the wires on an arm, projecting across to the other curb line.

Guys were prohibited, and the pole here illustrated was designed and built by Messrs. Milliken Bros., of 55 Liberty St., New York. This pole is of their regular type, modified to adapt it to the very unusual requirements of the case. The general dimensions were as follows: Length of pole 35 ft.; length of arm 32 ft. 8¼ ins.; height of arm above ground, 20 ft. 1¼ ins.; length of pole sunk in the ground, 7 ft. The total weight of the pole is 2,000 lbs., and it is designed to carry 500 lbs. at the end of the arm. Four of these special poles were required to pass the troublesome property.

As the cut does not show the details very clearly it may be well to generally describe the connections further. The arm is made of plates and angles, with proper struts and rods with adjusting devices. This arm is braced in a horizontal plane on the lower chord and at the end of the arm, and at a point near the pole, are loops for a No. 6 wire connection, to brace the arm against vibration. For some reason this latter bracing was not used. A sliding bracket adjusts the trolley in line over the track. We learn that these poles, though subject to an unusually heavy strain, stand perfectly erect and are satisfactory in every particular, and the designers say they are prepared to furnish them of larger dimensions should the conditions demand this.



ELECTRIC STREET RAILWAY POLE.

Col. William H. Paine.

The many and warm friends of Col. WILLIAM H. PAINE, an engineer famed for his professional works in times of peace and times of war, will be grieved to hear of his unexpected death in Cleveland, O., on Dec. 31. His funeral services were conducted at the Church of the Puritans, in Harlem, on the evening of Jan. 3, in the presence of about 30 members of the American Society of Civil Engineers, of which he was past Vice-President; of members of Hamilton Post, No. 182, G. A. R.; of the Harlem Republican Club, and of his associates in the construction of the Brooklyn Bridge, and other engineering and personal friends.

In addition to the meager notice in our last issue the following sketch of Col. PAINE's professional life, as based in great part upon a very detailed account in the Brooklyn *Daily Eagle* of Jan. 4, will be interesting to many readers:

Col. WILLIAM H. PAINE was born in Chester, N. H., May 17, 1828, of old New England stock. After completing an academic course he was engaged as a land surveyor in Northern Wisconsin and in 1852 was in California in the gold regions. In 1853 he made a survey across the Nevada Mountains, from Sacramento to Utah, on the line known as the Johnston route in the history of the Pacific railways. He returned to Wisconsin and was there engaged in railway surveys when the Civil War broke out. He at once took an active part in military matters and went to Washington with the Fourth Wisconsin Regiment just before the battle of Bull Run. Declining several important military commands, on the ground that his training as an engineer was more serviceable to his country in other fields, he finally became an unofficial "pathfinder" for the advancing army. In citizen's dress, with meager assistance and in almost constant and imminent danger, he performed most valuable service in obtaining information, the length of railway bridges that had to be rebuilt between Washington and Richmond, etc.

Mr. PAINE was then appointed a captain of engineers, despite the usages of the service. He was first regularly assigned to duty on the staff of General McDOWELL, and until the close of the war served with great usefulness and honor, and had the intimate friendship and confidence of men like Generals GRANT, HUMPHREYS and WASHBURNE. He was chiefly engaged in topographical surveys, and one of the elements of success in his engineering scouting experience was his intimate knowledge of the colored man and the use he made of this race in conducting his work. In this connection Colonel PAINE would often relate the following story of his colored body-servant, DABNEY WALKER by name. DABNEY had "the topographical instinct" rarely developed, and was shrewd and fearless. While the armies were watching each other across the Rappahannock, near Fredericksburg, DABNEY conceived and successfully carried out a novel system of telegraphing whereby he conveyed to his master early information of Confederate plans. His confederate was a washerwoman in the enemy's camp, and to her the information came from the body-servant of the Confederate general. The news was sent by arranging clothes of different colors and in different positions on her clothes-line, according to a code understood by themselves. After the war Colonel PAINE furnished many of the maps and much of the engineering information used in the works of Gen. H. SYLVESTER, HORACE GREELEY, Mr. SWINTON and other historians of the war of 1861-65.

Col. PAINE was connected with the construction of the Brooklyn Bridge from its inauguration. He was engaged in surveys for its location, in the building of the New York caisson and tower, and had general charge of the cable work on the bridge, including the system of rope traction still in use. He acted as a consulting engineer to the bridge until July, 1889, when he resigned and commenced a general practice as consulting engineer. Our Brooklyn contemporary omits to mention that Col. PAINE was the first consulting engineer to the Hudson River Tunnel, until November, 1879. His excellent work in the design and construction of the cable railway on Tenth Ave. and 125th St., in this city

is well known to engineers, and in his later practice he made cable railways his specialty. For a year previous to his death he had been engaged in the construction of a 20-mile line for the Cleveland City Cable Ry. Co. Col. PAINE became a member of the American Society of Civil Engineers on May 12, 1875, and served one term as Vice-President of that Society.

Colonel PAINE was a man of wide information, exceedingly quick of perception and as rapid in execution; of untiring industry and strong personality. His friends were firm friends and lasting, and his loss will be keenly felt by them. He was of Puritan stock, and while he was gentle in manner, he was as firm as a rock where his principles were in question, as when he exposed himself to court-martial rather than build a bridge on Sunday for General MCDOWELL. In a word, he was a most useful citizen, a valiant soldier and an engineer endowed by nature, and quickened by long training, with those qualities that make a man eminent in his profession.

Building in Earthquake Countries.*

In order to make this paper a sequel to a paper on the same subject, contributed to this Institution in 1885, the author has considered it advisable to give the following brief explanation of the nature of his first paper, which chiefly dealt with principles to be followed when constructing buildings in earthquake countries. The principles enunciated in the first paper were: 1. To select a site for a building, and to give it such foundations that it should receive the least possible quantity of the motion. 2 To construct a building in such a manner that it shall be able to resist best the particular kind of stresses which are the results of earthquake motion. To do this, among other things, it must be remembered that these stresses are in great measure applied horizontally, and therefore, for example, archwork is unsuitable to withstand earthquake motion. Again, it should be remembered that it is undesirable to couple together, unless they are coupled so that they move as a whole, parts of a building that are not likely to synchronize in their movements By neglecting this principle, brick chimneys are often destroyed when they pass through a wooden house. Lastly, centers of inertia should be kept low; it is therefore undesirable to give top weight, as in a roof or in the coping stones of chimneys.

CHOICE OF A SITE.

A good site may often be obtained in a given city by taking advantage of the results of experience. Thus, in the Ansei earthquake in Tokio, it was shown that the greatest destruction took place on the low soft ground. Although it is a general rule that hard high ground is best, it must not be overlooked that there have been exceptional cases where buildings in such localities have suffered, as in Yokohama in 1880, and to a certain extent in Calabria in 1783. In Tokio, as the result of personal feelings, it has been shown that earthquakes are more noticed on high ground than upon low ground. Instrumental observations, so far as they have gone, and the result of experience in 1885, have, however, proved that the most destructive motions have been experienced on low ground.

The best sites in a city may be determined, should it be thought advisable, by means of a specially organized seismic survey, which involves placing a number of similar seismographs throughout the area to be investigated, and a comparison of the records they furnish. By doing this a seismic survey may be made for a small piece of ground, say ¼ sq. mile or less in area. Such a survey was made of the compound of the late Imperial College of Engineering, now the Gakushuin, in Tokio. The results proved that of two similar houses on that compound, at a distance of less than 800 ft. apart, one of these houses might be destroyed by a given earthquake and the other suffer little if any damage. Until this survey was made, it was not suspected that the difference in motion on two sides of a particular piece of ground could be so pronounced. Very wet ground, or ground that is marshy, notably forms a bad foundation. Steep, sloping ground is also bad, the alluvial material resting on such a surface often sliding downwards, much in the same manner as tiles may slide from a steeply pitched roof. The sliding, or tendency to slide, is in all probability aggravated when the surface is loaded by a building. The upper edges of cliffs and scarps, where the motion of the free face of the cliff or scarp is naturally large, are also dangerous situations, and these more especially when the strata dip outward.

Seismic surveys have been made, and continue to be made, on an area embracing the whole of the Japanese empire. To do this there are about 650 stations recording every year about 500 different disturbances. The results are of considerable scientific importance, showing which portions of the empire are most shaken, and how seismic activity shifts from point to point. Their practical value, as compared with the records showing the differences in movement in an extremely small area, are, however, relatively small.

For such earthquakes as are experienced in Japan, and some of them bring down chimneys and unroof houses, seismologists on the spot have every confidence as to the accuracy of the records furnished by their instruments; the difference of a few millimeters of motion, or the fraction of a second in period, may determine whether damage will occur or not. The author is of opinion that an earthquake with a 25-millimeter (0.984-in.) amplitude and an ordinary period would wreck the half of London.

FOUNDATIONS.

As a result of observations made in a pit about 10 ft. in depth, it was found that the motion at the bottom of the pit was, in strong earthquakes, very much smaller than upon the surface. These observations led to the conclusion that great advantages might be gained by giving a building a deep foundation, this advantage being increased if the building rose freely, as in a house with an open area and a basement. That, at least, there is no harm in such a structure is attested by the fact that, in all earthquake countries under building regulations, cellars or basement archwork is recognized as admissible. That relatively little motion enters a building with such foundations is also attested by the fact that in cellars vaulting is allowed, whereas for stories above the ground floor it has invariably been suppressed. The author's own experiments in this direction gave a measurement of the relative motion above and below ground showing that deep foundations were not simply without danger, but that they might be advantageous. As, however, the experiments have only been made at one point, and as they are of so much importance to builders, they should be repeated.

The Ischiar regulations provide that buildings should be founded on the most solid ground. If, however, the ground is soft, a platform of masonry or cement should be formed, which, for a one-story building, must be 0.70 meter (2.30 ft.) thick, and for a two-story building 1.20 meter (3.94 ft.) thick. This platform must extend from 1 to 1.50 meters (3.28 to 4.92 ft.) beyond the base of the building. In Manila it is stipulated that the foundations must be able to bear at least twice the weight that is to be placed upon them. When the soil is bad, it must be piled or consolidated by a bed of hydraulic concrete, and the foundation of a building must so far as possible, be made continuous.

Another method of minimizing the motion received by a building is to give it free foundations. As an example of this, the author mentions a room attached to his own house, which rests at each of its pillar like foundations upon a layer of ¼-in. cast iron shot, between two iron plates. Short rollers, placed at right-angles, might be equally effective. This building has stood for many years. It has not been disturbed by typhoons, and at the time of an earthquake a seismograph inside the building shows, relatively to one outside, but little motion.

The ordinary Japanese dwelling house rests loosely on the upper surface of boulders or stones planted in the soil, and therefore it is difficult to conceive how it can receive the whole of the motion imparted by the shaking ground to its stone foundations. In temples and other large buildings with heavy roofs, which are common in the country, beneath the supporting timbers and the superstructures there is usually a multiplicity of timber joints, which at the time of an earthquake yield, and therefore do not communicate the whole of the motion from below to the parts above. In the great earthquake of Ansei, in 1855, so far as the author is aware the whole of these buildings remained intact. Certain roofs of considerable span in the engineering college at Toranomon, in Tokio, were built so that they rested freely on the supporting walls, the object being that they might remain, so far as possible, resting freely on the wall which moved beneath them. Although they have experienced many tolerably severe shakings, hitherto they have remained uninjured. These examples show, especially for horizontal components of motion, that if a small building is not firmly attached to its foundations, or if parts of a building have connection between them that readily yield, it is difficult to cause such a building to move or swing, and that, by a proper application of this principle, destruction may be, and has been, avoided.

Loose foundations might possibly be employed for small light buildings erected on soft ground. For ordinary dwelling houses, and especially for heavy structures covering a considerable area, the author is inclined to the opinion that solid continuous foundations in the hardest ground, and if possible surrounded by a free area, are the best. The objection to loose foundations for a large building is that different parts of the same building do not simultaneously receive momentum in the same direction and also in severe earthquakes there is an actual wave-like motion of the ground.

ARCH-WORK.

An ordinary arch is undoubtedly stable for vertically applied forces, but for horizontal stresses it is most unstable. Arch-work has so often been the cause of ruin when shaken by an earthquake, that, in Italy and Manila, special rules have been drawn up respecting such structures. Thus in Manila intersecting vaults are not allowed, and ordinary vaults are only permissible when strengthened in a particular manner by iron. In Liguria vaults can only be used in cellars, but even there the rise must be at least one-third of the span. The regulations also provide that above windows there shall be two iron bars. The law of Norcia also only permits the use of arch-work in cellars, and the thickness and method of construction is defined. In Ischia arch work with a rise of one-third of the span, and with a thickness of 0.25 meter (0.82 ft.) at the crown, may be used, but only in cellars.

Speaking generally, the use of arch-work above ground has been prohibited, and if it has existed after an earthquake, all governments who have paid attention to building have ordered its removal. Underground its use is permitted provided the arches are not too flat. This, however, only indicates that the motion beneath the surface is too small to destroy even a bad form of structure, and therefore such a form, if it be underground, is allowable.

DOORS AND WINDOWS.

In the building regulations for Norcia and Ischia, it is stated that openings should be placed vertically above each other. It appears to the author that if a series of openings like doors and windows in a wall be placed vertically above each other, it is much as if the wall had here and there been built with the joints of a line of bricks or stone continuing above each other, that is the uniformity of the wall has been destroyed by lines of weakness which will readily give way to horizontally-applied stresses.

An important point mentioned in the Ischian law is the position of doors and windows relatively to the freely vibrating end of a building, the limiting distance being 1.50 metre (4.92 ft.). Similar provisions are found in the regulations for Norcia and Liguria. This distance should, if possible, be made to depend upon the materials of which a wall is constructed, its dimensions and the size of the openings.

CHIMNEYS.

An important point, which constructors should keep before them, is to avoid coupling together two parts of a building having different vibrational periods, or else to couple them together so securely that they shall move as a whole. The subject has been written about, experimented upon, and emphasized in Japan since 1880. In that year, most of the wooden bungalows in Yokohama lost their brick chimneys, in consequence of the wooden framing of the house swinging against them and cutting them off. By itself a chimney may stand; but, when partially attached to a house, the house and the chimney are mutually destructive.

The rules regulating the construction of chimneys are but few. The Ischian law states that they should be isolated from the walls; that of Liguria that they should not be in the walls, not connected with the building, and low. Chimneys not being much required in Manila, nothing is said about them. Experience in Japan has taught householders to build their chimneys as short and thick as possible, to allow them to pass freely through the roof, and not to load them with heavy coping stones.

After the experiences of 1879 and 1880, many of the residents in Yokohama materially altered the form of their chimneys. In 1887, these buildings did not suffer, the buildings which did suffer chiefly being those put up subsequently to 1880, and without any regard to the experience of previous years.

CONNECTION BETWEEN DIFFERENT PORTIONS OF A BUILDING.

This leads to a consideration of the advantages to be gained by tying the different parts of the buildings together so that they shall vibrate as a whole. Since time immemorial buildings have been tied together with iron or with wooden rods; but some time previous to 1868, when San Francisco was shaken, a patent known as the Toye patent was taken out to improve the construction of sea-walls. This was made to apply to land structures. The City Hall and other buildings in San Francisco are built upon this plan, which consists in tying together the walls at each floor by transverse and fore and aft rods of steel or iron. A plan similar to this has been applied to several buildings in Tokio and Yokohama.

For such earthquakes as these buildings have experienced, excepting on one occasion when the chimneys of the German Hospital in Yokohama were more or less injured, they have stood well. This system, however, requires to be thoroughly executed; for if the rods be too few, or if the bearing surfaces be too small, rather than support a building they accelerate its destruction, especially at the points of contact. Such buildings, partly for this reason and partly on account of their expense, are not looked upon with favor in Italy. The Ischian law specifies that if iron bands or chains are used they must act upon a large surface.

ROOFS.

The advantage to be gained by making the upper portions of any structure light are very great. When a building with a heavy roof is suddenly moved forwards, the roof by its inertia tends to remain at rest. The re-

*Condensed from a paper by JOHN MILNE, F. R. S., read before the Institution of Civil Engineers.

sult of this is conducive to a fracture, between the lower part which has been removed quickly, and the upper part which has tended to remain at rest. In building regulations special reference is made to roofs, which must always be light, the material recommended being iron or zinc or felt, ordinary tiles being only permissible for buildings one story high, and not for habitations. Certain kinds of tiles have sometimes been regarded as permissible; but these require to be properly secured, and it is specified that in such cases there shall be a floor of planks above the ceiling. Tiles require to be especially well fastened near the eaves.

The difficulty with roofs made of sheet metal is, first to secure them from being disturbed during severe gales, and second, to protect the interior of the house from heat. In Manila the first end is accomplished by a system of bolting, while the latter is attained by a series of false ceilings.

The tie beams of trusses should extend at least two-thirds across the thickness of the wall, and not over the whole thickness, and these rest upon wall plates. The form of truss recommended in Manila is the one with a central post (king-post). For spaces greater than 7 meters (23 ft.) iron should be used, and trusses must be so placed as not to act upon weak points in the walls.

The Ischian law does not prohibit the use of flat roofs (*terrazzo*), but it provides that the framing of the same, shall be strong and covered with materials which are fairly light. The Commission, who reported to the government, condemned such roofs.

WALLS.

Walls, like chimneys, should be light and strong. If heavy, and especially if loaded in their upper parts by copings and balustrades, they may be fractured and shattered by their own inertia. The height to which walls may be taken with safety depends upon the material of which they are constructed, the nature of the roof, etc. In Ischia it was suggested to limit buildings to two stories, or a height of 7.5 meters (24.6 ft.). The regulations, however, give 10 meters (32.8 ft.) as a limiting height, and, if they must be of simple masonry, of tuf to a height of 4 meters (13.12 ft.), with a thickness of 0.70 meter (2.30 ft.). The committee suggested that external walls should be at least 0.30 meter (0 98 ft.) in thickness and that their uniformity should in no way be broken by openings for chimneys, pipes, etc.

The Ligurian regulations allow three stories above the cellar, and a height of 15 meters (49.2 ft.). The walls, if not built on the barrack system, should be at least 60 cm. (23.6 ins.) thick, and have a batter of one-twentieth of their height. The Norcian regulations allowed two stories above the cellar and a height of 8.5 meters (27.88 ft.). If a third story existed it was to be destroyed. The walls were to be thicker than ordinary, and their thickness was to vary with the material employed, and the height of the structure.

In Manila masonry walls of ordinary dwellings only reach the first story, the upper story being of timber. The walls for public buildings, however, may be higher. The regulations specify that the upper walls must not rest on a floor.

The length of a wall should not exceed twice its height unless supported by a buttress. The latter might be used at intervals not greater than twice the height of a wall. Its thickness must be one fifth of its height. Outside walls, transverse walls and buttresses, must be well united, while the corners of buildings should be supported by buttresses.

It would appear that the system of building with an upper story of wood resting on, and not built into, the supporting wall, and a light roof, ought to do much toward insuring the stability of a building. The weight of ordinary masonry may be reduced by the adoption of hollow bricks.

BALCONIES AND CORNICES.

In Ischia it was suggested that balconies shall not project more than 0.60 meter (1.97 ft.) beyond the wall, and should be so constructed as to form a part of the wall.

The regulations provide that cornices shall not project more than 0.30 meter (0.98 ft) beyond a wall.

The Ligurian regulations provide that cornices shall not project beyond the thickness of the wall to which they are attached. Roofs may not rest on cornices. Stone consoles must run through the wall to which they are attached. In Manila the regulations require that the balconies shall rest on the prolongation of timbers of the upper floor, otherwise a special form of construction is required.

Many of the balconies, or upper verandas, seen by the author in Manila, were without support on their outer sides. In such instances they act as loaded cantilevers, which, either for horizontal or for vertical motions of the building, must cause considerable stress at their points of junction with the supporting wall. A careful examination of several hundred brick houses in Tokio showed that the walls were usually cracked at the points when they were entered by the beams supporting a balcony, notwithstanding that the same balconies were supported along their outer face by vertical pillars rising from the ground. The author's opinion is that balconies in any form are objectionable features in a building constructed to withstand earthquakes.

SHAPE AND ORIENTATION OF BUILDINGS.

In Liguria and Ischia, the regulations provide that a building shall be rectangular in plan, and as nearly as possible square. Churches should be small, and of the basilic form, with three naves, and iron columns between the naves. The Norcian regulations also recommend a square form.

In Ischia it was suggested that buildings should be placed so that the direction of the principal motion they were likely to receive should be along the diagonal of their plan. A result like this might be obtained by laying out the streets and roads in proper directions. Rossi suggested that the most resistant sides of buildings should be placed at right-angles to the nearest line of volcanic fracture, he holding the opinion that earthquake vibrations are propagated normally from the lips of such fracture.

The suggestion that buildings should be on a rectangular plan, or simple in shape, is worthy of consideration. It would certainly seem that such buildings would be subject to less destructive stresses than those largely built up of wings and other projecting parts, no two of which could be expected to vibrate in unison.

Whether any great good may be gained by giving proper orientation to a building is not certain. In Tokio walls extending in certain directions have been cracked more than others, and at the times of great earthquakes the destruction has been greater in streets running in a particular direction rather than in other directions. Streets ought to be wide, inasmuch as they would then form a refuge from falling debris.

FLOORS.

It was suggested in Ischia that floor joists should rest with their whole thickness on the walls. If possible, joists should cross each other at right-angles, and the floor planking be laid diagonally.

BERTELLI proposes a system of flooring of iron beams connected by brick vaulting, or in place of this ordinary joists and planking. The beams on one story should be at right angles to those on another. In all cases the joists are to extend completely through a wall. This regulation is also contained in the Norcian edict.

From these notes it appears that the intention of the authors of the regulations has been to utilize the floors to bind the buildings together as a rigid whole, and allow joists to extend so far into walls that there is no danger of their being drawn from their supports.

TYPES OF BUILDING.

The type of building most suitable for earthquake countries was discussed at considerable length by the commission summoned after the disaster in Ischia.

The objections to iron buildings chiefly rested on their cost, the difficulty of keeping them cool, and the fact that as they were a novelty, it might be difficult to get them generally accepted. The commission, however, considered them durable and secure, and recommended that experimental buildings should be erected.

Timber buildings, although sufficiently strong and elastic to resist earthquake motion, and at the same time impervious to heat, have the objection that they are not durable, and are liable to take fire. These objections may to some extent be overcome by the proper application of paints and chemical preservatives. Mixed constructions of iron and timber were not considered to present great advantages over those wholly made of timber.

Buildings may be made of iron or masonry either by covering an iron framework with stone or brick, by building an iron framework inside the masonry walls, or by filling up the spaces between a double metallic framework with hollow bricks or other materials. Such buildings, although good from many points of view, have the drawback that they are exceedingly expensive.

Having considered these types, from which it will be observed ordinary buildings of brick and masonry have been excluded, the committee describes a "barrack" system of building, which is the system particularly recommended for Ischia. Briefly, such a building consists of a timber framework well braced together, the spaces between the timbers being filled up with hollow bricks, or some light material like scoria. The timbering is hidden by rough cast. After the disaster in 1755, such a system was made compulsory in Portugal. A building of this type, which may be ornamented with an outside covering of tiles, is cheap, impervious to heat, and safe against earthquakes and fires. The suggestion respecting this system of construction was adopted in the regulations issued by the government.

In the building regulations for Norcia, the barrack system is the one to which preference is given. In the Manila regulations considerable latitude is allowed as to the system of construction; stone walls are thought best, but concrete or brick are also approved of. Although timber offers great resistance to earthquakes, its destructibility by fire, white ants, ordinary rot, and its inability to exclude heat, prevent its recommendation. An iron framework filled in with concrete is spoken of with favor. In the recommendations of a committee appointed to consider building in Manila, stone suggested for the base ment and for the walls of the ground floor. This, with an upper story of timber, is the type of building common in Manila.

The military committee, which was summoned in connection with the destruction in Manila in 1863, pointed out that destruction had occurred in all classes of buildings, but that buildings with masonry supports had suffered more than others. This led to the suggestion that only one kind of material should be used in construction, and that masonry supports should be avoided. Private buildings should be of wood. In all cases the limiting spans of roofs were specified, and that the roofs must be light. Lieutenant-Colonel CORTES, who wrote at some length on structures in earthquake countries, shows that buildings must be light, as well as strong, and this may be obtained by building their parts together, much in the same manner that the timbers of a ship are bound together. Foundations and walls should be continuous. Timber work and masonry should not come in contact, otherwise they may be mutually destructive.

After criticising the system of building in Manila, and showing how it may be improved, especially with regard to balconies and roofs, Colonel CORTES proposes as a foundation a timber platform, almost on the surface of the ground, from which rises a building with iron or timber framing, footed on a dado of masonry, surmounted by a light roof. The wall framing may be filled with brick or plaster. Colonel CORTES' descriptions are accompanied by an elaborate series of illustrations.

In Colombia the smaller houses have been built of thick adobe bricks, while the Spanish have used stone. In Ecuador (Quito) occasionally a special earthquake-proof room is built, the walls of which are a wooden framework, filled in with adobe. Many houses which have adobe walls 3 ft. thick have only one story, and there are few houses with more than one upper story. In Venezuela, also, the houses are low. In Mexico and in Bolivia the houses are solidly built, while in Lima certain buildings are constructed lightly, so that they may yield.

PERSONALS.

Mr. MEEK, General Manager of the Denver & Fort Worth division of the Union Pacific Ry., has resigned.

Mr. E. G. ALLEN has been appointed Superintendent of the main line of the Old Colony R. R.

Mr. A. H. RAYNAL, Superintendent of the Richmond Locomotive & Machine Works, of Richmond, Va., has resigned.

Mr. CHARLES N. YEAMANS, Superintendent of the Northampton division of the New York, New Haven & Hartford R. R., has resigned.

Mr. WM. WAINWRIGHT, Assistant Manager of the Grand Trunk R. R., has been appointed Assistant General Manager.

Mr. CHARLES FENSTERMACHER has been appointed Assistant Engineer of the Shenandoah division of the Norfolk & Western R. R.

Mr. W. A. CALHOUN, C. E., formerly of the firm of W. R. Coats & Co., of Owosso, Mich., has opened an office as "engineering agent" at Green Bay, Wis.

Mr. H. O. POND, Superintendent of Transportation of the Columbus, Shawnee & Hocking Ry., has been appointed Superintendent of the road.

Messrs. VAILE & YOUNG, Maryland Galvanized Iron Works, of Baltimore, Md., have moved their office and works from 309 North St, to 216 North Calvert St.

Mr. ADDISON CONNOR, M. Am. Soc. C. E., Assistant Engineer in the Dock Department, New York City, died Jan. 4. He had been an engineer on the Northern Pacific R. R., and on the bridge at Cairo, Ill.

Mr. J. H. BARRETT, Superintendent of Transportation of the New York, Lake Erie & Western R. R., has been appointed General Superintendent. His successor is Mr. W. H. STARR.

Mr. EVERETT E. STONE has been appointed Roadmaster of the second division of the Boston & Albany R. R., Worcester to Springfield and branches, vice Mr. P. M. BUTLER, deceased. Mr. ROYAL A. MCQUAID has been appointed Assistant Roadmaster of the division, vice Mr. STONE, promoted.

Mr. JOHN C. CHASE, C. E., for many years past, and continuing, City Engineer and Superintendent of the Clarendon water-works, Wilmington, N. C., and Mr. J. H. MCREE, C. E., late of the Cape Fear & Yadkin Valley R. R., have entered into partnership as civil engineers with office in Wilmington, N. C.

Prof. O. H. LANDRETH, Dr. J. P. DRAKE and Mr. J. W. GAINES were appointed on Dec. 20, by the Commercial Club of Nashville, a committee to investigate the public road question. The committee is to report to the club what action, if any, should be taken to secure the passage of a general road law for the State by the next Legislature.

NEW PUBLICATIONS.

JANUARY MAGAZINES.

The monthlies still remain in a holiday humor, not a single one of them containing any articles of especial interest relating to the exact sciences. Perhaps the most really notable is a short one, not written with any scientific motive, on "The Decline of Superannuation," in which some striking facts are gathered as to the lengthening out of the working life which has taken place since a hundred years ago, and the real cause for which is the immense improvement in the sanitary conditions of life which has taken place since then, rather than any change in the minds of men as to what stage of mental and physical decay makes superannuation proper.

Harper's has two continued descriptive articles on Southern California and Peru, which continue good, and *Scribner's* a readable and well illustrated, but not very technical, article, on "Modern Fire Apparatus." A grand view of "Govett's Leap," in Australia, on page 81, bears an amazingly exact resemblance to an almost unknown waterfall between San Blas and Tepic, on the west coast of Mexico, which makes a sheer leap of 480 ft. over the edge of a like volcanic sink-hole.

The *Forum* has an article which ought to be of special interest on "Reform in Railway Construction," by Mr. OBERLIN SMITH, President of the American Society of Mechanical Engineers. But we regret that it is not. When a man undertakes to show the faults of management in a great industrial interest he should either speak from his own knowledge or disabuse his mind of the impression that all those who have actual charge of the works which he criticizes from a distance are ignoramuses, because blind to truths so clear to him Mr. SMITH does neither. Instead of mentally putting himself in the place of those who are actually struggling with the real or supposed difficulties which he enumerates, he imagines himself speaking in the name of "some highly educated physicist and engineer from another planet," who "after a year's general study," proceeds to unsparingly condemn the modern railway. He will we trust, pardon us for suggesting that while the "other planet" point of view is evident enough, the "year's general study" is not so evident in the imaginary conclusions of this gifted being, which read more as if they might have come from a physicist of very ordinary gifts on this very ordinary planet, and from one who had not had occasion to practically study any phase of the railway problem, physical or financial. Not but that some of the defects noted exist, for the standard chosen is perfection; but most of the remedies chosen are worse than the disease, and the disease itself is less serious than in almost any other great department of human effort, as our "other planet" visitor would soon find out if his high education had taught him to be careful about jumping at conclusions. The remarks on the evils of dead weight, for example, show a plentiful lack of study of the real nature of the problem. Such articles do harm, by diverting attention from really serious and really remediable evils.

The *Popular Science Monthly* contains an excellent illustrated resumé of the problem of "Storage of Electricity," and a brief but interesting further note on "Star-Streams and Nebulæ."

In the *North American Review* Mr. HENRY CABOT LODGE discusses some unfortunate facts often mentioned in this journal as to the recent immigration. He shows that between 1874 and 1889, 6,418,633 persons immigrated to the United States, an average of over 400,000 per year, and rising to over 700,000 in each of two years in the period named. The classification of these newcomers, between 1873 and 1886, shows that 48.1% of these immigrants were persons avowedly without education or training, or, in other words, represented unskilled labor of the lowest kind.

Mr. LODGE then points out that while the mass of these immigrants still come from Great Britain and Germany, and belong to nations readily assimilating with the people of this country, the immigration from these two sources is declining rapidly in comparison with the increase from Italy and the Slavic countries of Russia, Poland, Hungary and Bohemia. He suggests restriction, to protect American labor against undue competition by the class named, and to guard against an infusion of harmful elements into our population. Immigrants should be forced to bring from their native country, from U. S. consuls, etc., an effective certificate that they are not obnoxious to any existing laws of the United States, and a medical certificate should also accompany this.

In the same number, Mr. A. M. CUMMINGS shows his unbelief in the commercial value of flying machines, of any type. He thinks that flying machines for the use of the individual traveler are among the near possibilities; but that the world has as little use for them as it has for the North Pole. When it comes to competing with railway trains and steamships, for the transfer of large volumes of freight and passengers, Mr. CUMMINGS pertinently points out that the consumption of power necessary to lift this dead weight into the air must far exceed that required for horizontal transport on metal rails or in water. He sees no commercial gain in the change from the surface to aerial traffic. But in the case of railways at least, he seemingly does not include in his calculations, the question of roadway construction as compared with the cost of the vehicle alone.

—*Geographic Names*, U. S. Board on, Bulletin No. 1, Dec. 31, 1890. Published by the Smithsonian Institution, Washington, D. C. This is a new departure for the Government, and has for its purpose the adjustment and fixing by authority of the now various and conflicting spelling and pronunciation of geographical names. To this end President HARRISON, on Sept. 4, 1890, appointed a board, of which Prof. THOMAS C. MENDENHALL, of the U. S. Coast and Geodetic Survey, is chairman. This issue of the bulletin gives the principles adopted for the guidance of the board in determining the official form or rendering of geographical names. The ruling principle is to adopt that spelling and pronunciation sanctioned by local usage, wherever possible. Generally speaking, no attempt will be made to restore changed or corrupted names, when the changed form has become established. Foreign names, where Roman characters are used, are to be rendered in the form adopted by the country having jurisdiction, unless an English equivalent is already well fixed by usage. The bulletin gives a list of 226 names of places so treated, as a first instalment, and also an interesting note on the orthography of "Bering Sea," by Mr. MARCUS BAKER, of the U. S. Geological Survey.

TRADE PUBLICATIONS.

—*The Roney Mechanical Stoker*, Westinghouse, Church Kerr & Co., Chicago and New York. Pamph., pp. 33. This is an excellently illustrated catalogue of a device which has met with greater success than any form of mechanical stoker ever tried in this country. The descriptive matter is of considerable technical interest.

—*Stone Working Machinery*. Lincoln Iron Works, Rutland, Vt. Pamph., pp. 76. This firm is located at the center of the Vermont marble district, and makes a specialty of stone sawing machines, automatic sand feeding devices, stone planing and jointing machines, and other tools used by quarrymen.

Some New Trucks.—The Kilbourne & Jacobs Mfg. Co., Columbus, O. This company celebrated the New Year by sending out a little pamphlet describing some novel styles of trucks for special uses just placed on the market, among which may be especially noticed a steel charging barrow for blast furnace and gas works use, fitted with roller bearings.

—*Catalogue of Merchant & Co.*, importers, manufacturers and dealers in metals, Philadelphia, Pa.—The subtitle to this trade publication is—"A Midsummer Night's Dream, being a somnambulistic ramble with Merchant & Co., and their friends, the Brownies." The illustrations are of the "brownie" type, made famous by the facile pencil of Palmer Cox; and while they are technical in their surroundings and application they are so artistic, so humorous, and altogether so well handled that we heartily congratulate Merchant & Co on their happy thought and the exceedingly handsome manner in which they have clothed this "thought." We have no hesitation in saying that it is the most "taking" catalogue that has ever reached this office and foretell for it an "overwhelming circulation."

SOCIETY PROCEEDINGS.

New England Railroad Club.—The subject for the next meeting to be held Jan. 14 at the United States Hotel, Boston, will be "What Constitutes a Defect in a Vertical Plane Coupler Sufficient to Condemn It?"

The Western Society of Engineers, at its annual meeting of Jan 7, elected the following officers for 1891; President, L. E. Cooley; Vice-Presidents, J. F. Wallace, J. O. Seymour; Secretary, John W. Weston; Trustee, Octave Chanute. About 200 members and guests were present.

New England Water-Works Association.—At the regular quarterly meeting of the association, at Young's Hotel, Boston, Jan. 14, a paper will be read by Mr. F. P. STEARNS, Chief Engineer of the Massachusetts State Board of Health, on "The Effect of Storage upon the Quality of Water." After the paper has been discussed the usual brief experience papers will be presented by the members. The rooms will be open to members at 11 A. M. At 12 o'clock the Executive Committee will hold a meeting, and at one o'clock lunch will be served. The paper will be presented at 2 P. M.

Engineers' Club of Cincinnati.—The Third Annual Meeting was held on Dec. 18. The average attendance at meetings during the year was 25⅞, and the total membership to date is 96. One paper was read at each meeting and on one evening a budget of six short papers was presented. The club is out of debt, and has a satisfactory balance in the treasury. The following officers were elected for the year 1891: President Robert L. Read; Vice-President, Ward Baldwin; Directors, Epes Randolph, W. B. Ruggles, S. Whinery; Secretary Treasurer and Librarian, J. F. Wilson. The retiring President, Mr. G. B. Nicholson, in his address reviewed the history and progress of the club and congratulated the members on its present prosperity. He urged the desirability of procuring permanent quarters and a proper library. In concluding he gave a short description of the works of engineering interest in and about Cincinnati.

American Society of Civil Engineers.—The regular monthly meeting was held Jan. 7, President Wm. P. Shinn in the chair. The Secretary announced the deaths of Col. Wm. H. Paine, past vice-president, and Mr. Addison Connor. In regard to the annual meeting it was stated that arrangements were being made to visit the pneumatic signaling plant at the Grand Central Depot, the New York *World* building, the intercepting sewer and the water supply wells in Brooklyn, and the new station of the Pennsylvania R. R. at Jersey City. A paper on the "Chignecto Ship Ry." will be read on the evening of Jan. 21. The secretary read a letter from the Brazilian Minister at Washington, stating that Brazil now offers a good field for engineers.

The subject for discussion was the paper by Mr. T. G. Gribble on "Street Railway Track," which was read Dec. 17, and an abstract of which was given in ENGINEERING NEWS, Dec. 20, 1890. The first discussion was read by Mr. Elwell; he referred especially to the difficulty of securing good joints and the importance of such joints for first-class track; and claimed several advantages for the Gibbon track. Mr. Gibbon, the inventor of the "duplex rail" track, described in ENGINEERING NEWS Nov. 15, then read a lengthy paper dealing in a very general manner with the requirements for a good track, setting forth the claims for his track and the defects of other forms of track from his point of view. Mr. Brinckerhoff stated that it was originally intended to lay street car tracks along the roadways of the Brooklyn Bridge; the track on the approaches was to consist of grooved rails of saddle section resting on stringers built up of two rolled beams bolted together and filled with concrete. The stringers were to rest on a concrete base, and the rails were to be fastened to them by bolts passing through the bottom of the groove. Mr. Tratman, in a written discussion, thought that the shallowness and want of stiffness of Mr. Gribbie's rail, relying entirely on the cast-iron stringer filled with concrete for stiffness of track, might be an objection. He questioned whether it would not be better to use less material in the fastenings, and more in the depth of the rail. For a track with heavy traffic he was inclined to prefer a rail with a middle web but no bottom flange. Mr. Gribble considered that no web was needed for a rail, if the track was properly built on his system. In regard to the hard riding of cars, he considered this to be due more to a dirty track than to a rigid construction of the track. Mr. Wm. P. Shinn referred to the frequent statements made as to the desirability of an elastic track, but he thought the value of elasticity was frequently overestimated. With a perfect track elasticity is not wanted, and street railway men should try more to secure a smooth track than an elastic track.

In the course of the discussion it was stated that a suburban line of the Georgetown & Tenalleytown Ry., at Washington, D. C., was laid with the rail ends close together; the rails were of T section, and the earth was tightly packed around them. No trouble from expansion had been experienced, the earth keeping the temperature uniform, but it was remarked that the track might have been laid in hot weather. Mr. Cohen referred to a compound rail designed by Mr. Latrobe, formerly Chief Engineer of the Baltimore & Ohio R. R., and tried on that road. It give considerable trouble by its expansion, and a singular feature was that one rail traveled east and the other west. Mr. Harris stated that a similar peculiarity had been noticed with a T-rail track on Market St., San Francisco.

After the meeting, Mr. Geo. S. Greene, Jr., Treasurer, presented a statement showing that the cost of the collations during the past year had been less than during the previous years. Mr. J. J. R. Croes exhibited a diagram of the comparative growth of the American Society of Civil Engineers and the Institution of Civil Engineers, showing that of the former to be proportionately greater than that of the latter.

The following candidates were declared elected:

MEMBERS.

Charles I. Brown, Engineer, St. Louis & San Francisco R. R., St. Louis, Mo.; Charles W. Hazleton, Engineer, Turners Falls Co., Turners Falls, Mass.; Frederick E. Sickels, Chief Engineer, Kansas City (Mo.) Water-Works; Geo. Westinghouse, Jr., Pittsburg, Pa.

JUNIORS.

Louis D. Fouquet, N. Y., O. & W. Ry., Walton, N. Y.; Clinton L. Riggs, Robt. Poole & Son Co., Baltimore, Md.

Am. Soc. Civil Engineers.—The St. Louis circular, signed by Messrs. J. B. Johnson and M. L. Holman, has appeared, setting forth the reasons governing a number of members of the Society in that section for advocating reform in the business management of the Society, and the ticket which proposes that reform. The circular discusses the situation as a question of business policy alone, but it sets forth the record and qualifications of the several candidates on the ticket advocated. The arguments used are now familiar to members.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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Chas. W. Baker, E. E. R. Tratman, M. N. Baker, F. P. Burt, } Associate Editors
Geo. H. Frost.....Business Manager

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COMING TECHNICAL MEETINGS.

Civil Engineers' Club of Cleveland.—Next meeting, Jan. 13. Secy., A. H. Porter, 50 Euclid Ave.

New England Railroad Club.—Next meeting, Jan. 14. Secy., F. M. Curtis.

Civil Engineers' Association of Kansas.—Next meeting, Jan. 14. Secy., J. C. Herring, Wichita, Kan.

Southern and Southwestern Railway Club.—Next meeting Jan. 15, at Atlanta, Ga. Secy., W. H. Marshall, Rookery, Chicago.

New York Railway Club.—Next meeting, Jan. 15. Rooms, Gilsey House. Secy., H. G. Prout.

Engineers' Club of Cincinnati.—Next meeting, Jan. 15. Secy., J. F. Wilson.

Northwest Railroad Club.—Next meeting, Jan. 16. Secy., H. P. Robinson, St. Paul, Minn.

Northwestern Track and Bridge Association.—Next meeting, Jan. 16. Secy., D. W. Meeker, St. Paul, Minn.

Engineers' Club of Philadelphia.—Next meeting, Jan. 17. Secy., Howard Murphy, 1122 Girard St.

Western Railway Club.—Next meeting, Jan. 20. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Jan. 20. Secy., S. M. Wickersham, Pittsburg, Pa.

Michigan Engineering Society.—Annual convention, Jan. 20 to 23, at Lansing. Secy., F. Hodgman, Climax.

Boston Society of Civil Engineers.—Next meeting, Jan. 21. Secy., S. E. Tinkham.

Engineers' Club of St. Louis.—Next meeting, Jan. 21. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Annual meeting, Jan. 21. Secy., John Bogart, 127 E. 23d St., New York.

Denver Society of Civil Engineers.—Next meeting, Jan. 27. Secy., Geo. H. Angell.

Civil Engineers' Society of St. Paul.—Next meeting, Feb. 2. Secy., G. L. Wilson.

Western Society of Engineers.—Next meeting, Feb. 3. Secy., J. W. Weston, 230 La Salle St., Chicago.

Technical Society of the Pacific Coast.—Next meeting Feb. 6. Secy., O. von Geldern, 408 California St., San Francisco.

Engineering Association of the Southwest.—Next meeting, Feb. 12. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

We take advantage of a query put to us by a correspondent to say a few words on the position taken by this journal in the pending contest in the American Society of Civil Engineers. In substance, our correspondent asks, "What business have you, as a technical paper, to meddle with the internal policy of the American Society of Civil Engineers; and are you not doing an injury to that Society by publicly censuring its past management?" We will answer these questions in their order. First, as a technical journal we believe it is our duty to discuss fearlessly all matters concerning engineering and the advancement of the profession in this country. In the matter in question this duty becomes personally an unpleasant one as it seemingly arrays us against personal friends. But with many other engineers, inside the Society and out of it, we have been convinced that if the Society is to maintain its past good record and to advance in influence with the times, some radical changes will have to be made in its organization and management. The reasons for the new departure lie both within and without the Society, in the rapid growth of local societies and in the inactivity in certain directions of the parent Society. The details of these reasons are patent to all thinking members, and we will not recount them here.

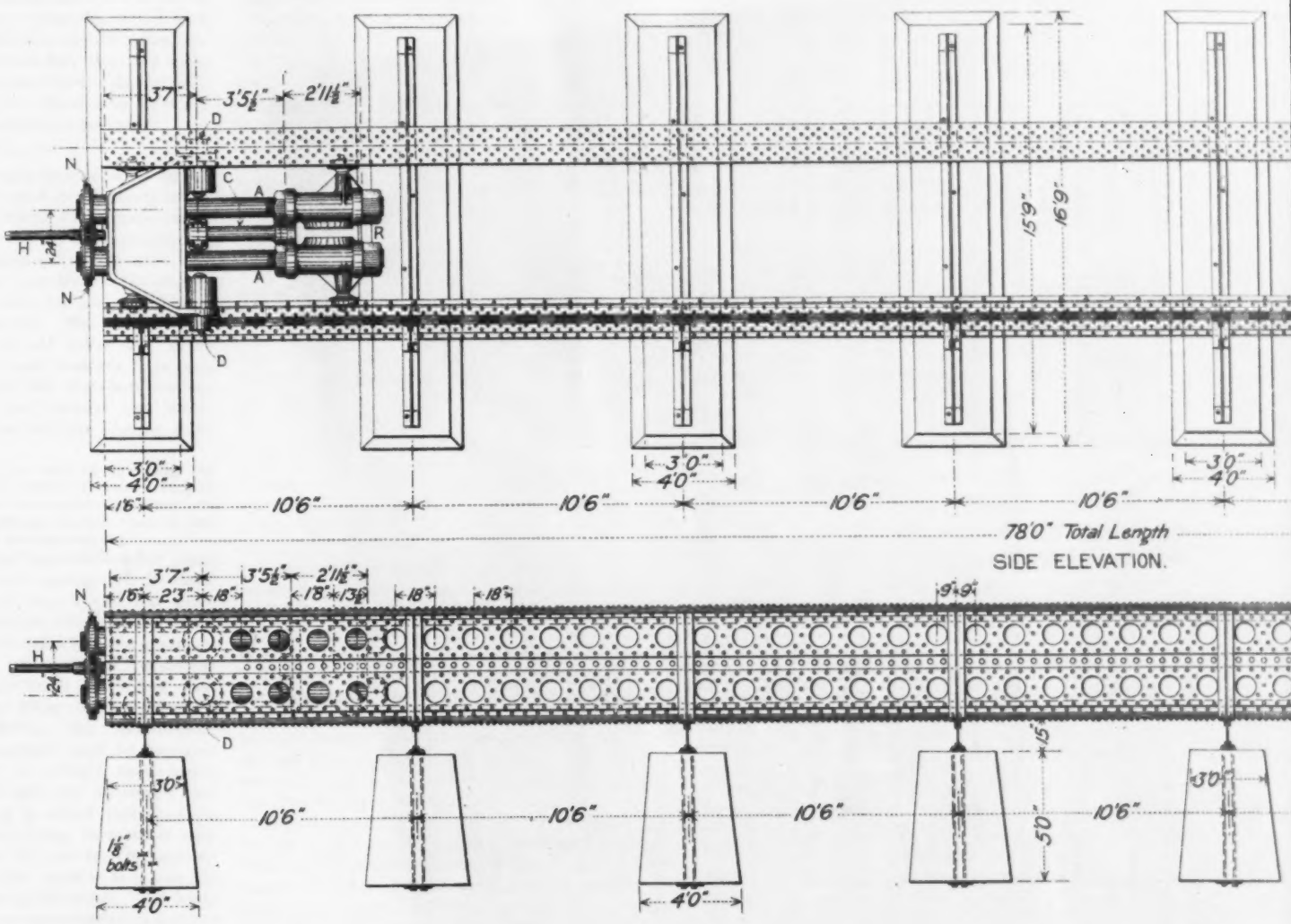
But while these reasons were well known for several years past, it was, and always will be, a delicate matter for members to question any personal shortcomings at a regular meeting. Those who knew would not talk, and those who were ignorant of the causes simply wondered at the unsatisfactory results. The action of the late nominating committee in proposing a new board, and especially a new executive officer, or secretary, had the appearance of promising some active work in the direction of reform. It was then that we considered it our duty to advocate this reform, and in so doing we have made every effort to avoid personal attacks, and to simply point out some of the reasons why such a reform was desirable. An effort has been made by adroit interviews in the daily press to connect this journal personally with the new movement. That we have not and can have nothing personally to gain in the course we have taken is plain to any thinking member. But as an engineering journal we have fearlessly expressed our opinion upon matters important to engineers, and will continue so to do, and we know no subject of more general importance than the present issue. The existing difference of opinion centers in the office of secretary, and we here want it distinctly understood that for the present incumbent of the office of secretary we have none but the kindest personal feeling and fully appreciate the most excellent work done by him when he was the actual hard-working secretary of the Society. The fault we find is with the working of the office during the time that he has been State Engineer, and a consulting engineer in active practice, and *not* Secretary *per se* of the American Society of Civil Engineers. We agree with those who believe that the conduct of this office has a most important bearing upon the usefulness of the Society, and that the conditions of the past few years and the growth of local engineering societies make it imperative that the whole work of a young and active business man be devoted to the Society's interests. That the Society cannot be successfully conducted on the present lines we believe we have fairly well proven in previous issues, if other evidence than its own published transactions were needed, and the ticket that we oppose promises little improvement on past methods.

This is not "a faction fight," as far as we are concerned, and as far as those others who have taken a live personal interest in it are concerned, though it is to the interest of some few members to make it appear so. It is an honest difference of opinion upon methods, not persons. The second question of our correspondent can be briefly answered. We do not believe that the honest discussion of matters of policy is likely in any manner to injure the Society, and any public discussion would certainly do less lasting harm than the continuance of the past methods objected to. We speak, editorially, to three-fourths of the membership of this Society; and to our engineering readers not members, this discussion is interesting as showing renewed life in the Society and an effort to improve the status of the organization. In social affairs, as in the human body, friction is required to bring about a healthy reaction; and whatever the personal issue of the coming election may be, we are convinced that some permanent good will result from the agitation it is now going through. But that the expression of opinion may be full, and the guiding policy of the Society defined without any doubt, we earnestly hope that every member will cast his ballot as his conscience and knowledge of affairs or live interest in the Society may dictate.

The establishment of a government bureau for officially settling the orthography and pronunciation of geographical names will be very generally regarded with favor. But we hardly agree with the determination of this board, as announced in the "guiding principles" laid down, to avoid as much as possible the restoration of changed and corrupted names. We can appreciate the social and commercial reasons for adhering to an established name, but it seems to us that the historical feature is quite as important. Geographical names very often perpetuate events and individuals that have both a sentimental and useful purpose to serve in being handed down in their original form. It is true that "Townsend Gut," on the coast of Maine, is not quite so elegant a term as "Town's End," the present form. But the one means an inlet and preserves the name of a possible discoverer, and the other name is an absurdity. This is one of the names very properly restored by the board to its original form; but it illustrates the point we wish to make, that it is very often better to antagonize local usage and local preference than to preserve a meaningless, lying form. The first issue of the bulletin treats mainly of names in Alaska, and it is satisfactory to note that under the adopted forms less vocal gymnastics are required in pronouncing the most of them. For example, Tschikschagoff may be easy enough for a Russian, who can pronounce anything; but Chichagof is certainly better for the American tongue. Shishmaref, for Schischmareff, Kutozof, for Kutusoff, Chigul for Tshigul, etc., may conflict with the rule one lays down for adhering to original names; but in the case of Russian terms it would seem that the board were justified in adopting simpler forms. The Russian alphabet exceeds ours by 10 letters, and it is simply impossible to find a proper English equivalent for some of their words, or to pronounce them in their native form. Among some more familiar names treated of we find Bering, for Behring; the latter being the German rendition of the name of Captain Ivan Ivanovich Bering, who had the honor of first exploring this sea. Mt. Rainier for Mt. Tacoma, in Washington, will probably not please the inhabitants of the lively city of the latter name; but Rainier is the older and the correct term and is now made official. Another much twisted name is Baluchistan, as it is now declared to read, and not Belochistan, Belouchistan, Balouchistan or Belutchistan, as given by various writers. Tristan da Cunha, for Tristan d' Acunha Island in the South Atlantic, is still another change made in a familiar but abused form.

In connection with the articles of Mr. Hale, in this and preceding issues, on the permeability of brick, we noticed a bit of record keeping that may be new to some of our readers. As every engineer knows, sand is an important item in the work usually under his charge. And it is quite as important, on all works of magnitude especially, that the character of the sand that enters into the mortar should be closely watched, and a standard adopted and adhered to as rigidly as possible. On the new Croton Aqueduct sand was obtained from various localities, and these samples, as well as standard sands for cement testing as passed through sieves of different size of mesh, were permanently put on record, not in bottles, etc., but in

SECTIONAL PLAN.



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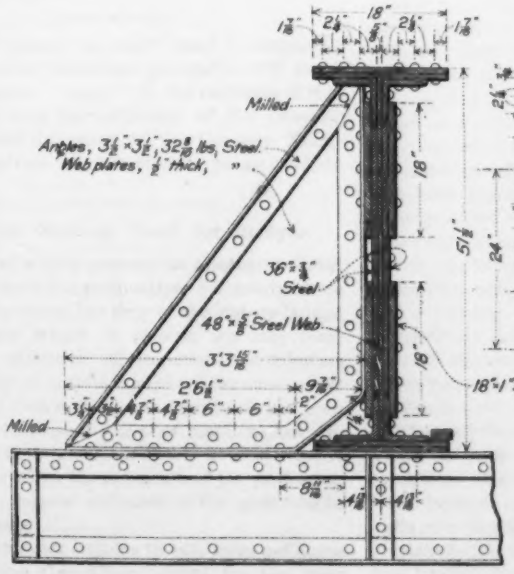

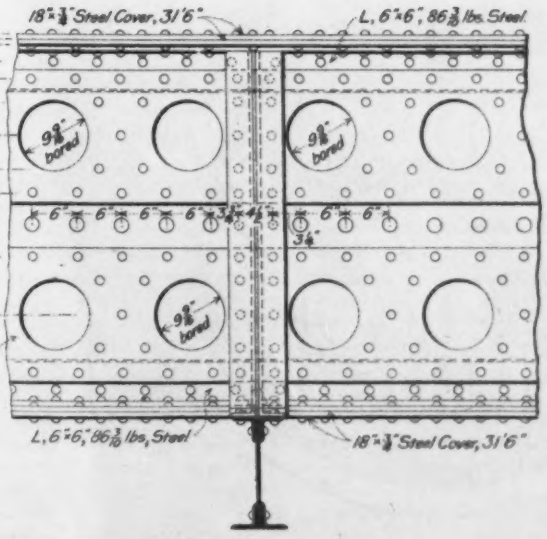

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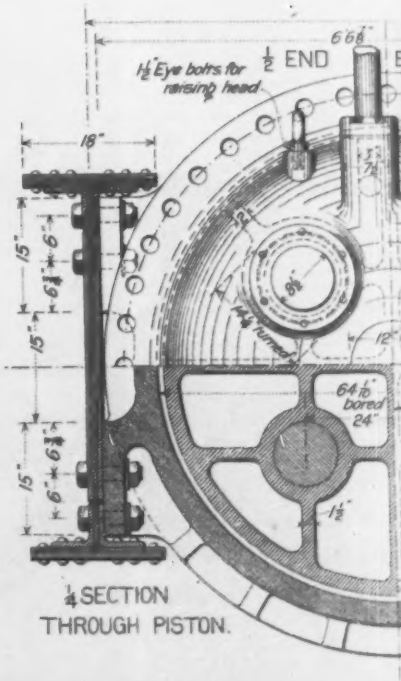

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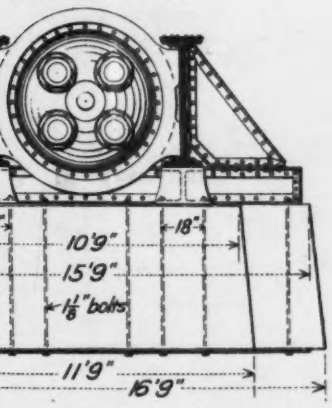
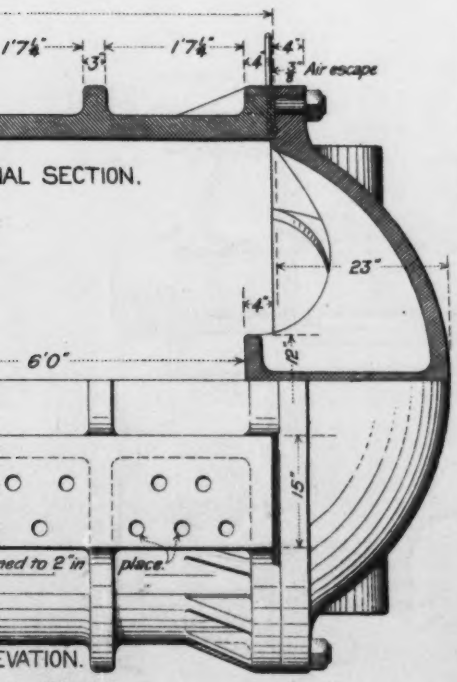




NAL SECTION.

EVATION.

o be of Steel.

CHAS. HART & SONS, LITH., 95 VESEY ST., N.Y.

books. The method was simple enough. A templet of the desired size was used for putting a thick coat of mucilage on a page of the record-book, and the selected sand was then sprinkled on this mucilage. The advantages are—that the record is in neat and easily accessible form, and all notes concerning the location, character, etc., are made on the same page. It is one of those simple little things worth knowing by those who have not come across the idea elsewhere in practice.

IRRIGATION in California is having what promises to be a healthy and rapid development under the "Wright Irrigation District Law," passed some three years ago. Under this act a community can organize, issue bonds, assess and collect taxes, construct irrigation works or purchase works already constructed, and adopt rules for the distribution of water within the district. The law provides that the bonds shall not be sold below 90. Since the law went into effect many districts have been organized and over $10,000,000 have been realized from the sale of bonds. In February last Washington passed a similar act and the Helena *Independent* says :

If the Legislature of Montana shall at its coming session pass a bill similar to the "Wright Irrigation District Law" of California, with a few amendments, they will have done more for the State of Montana than by any other legislation they could have undertaken.

The *Independent* states that within a few years 30 irrigation companies have sprung up in Montana many of which have built large works; but there is not a single large irrigation canal in the State owned by farmers However irrigating questions and State or general governmental regulation of them may be regarded, it is evident that speedy and firm action along definite lines is a necessity. The California and Washington laws have much to commend them, as they give farmers an opportunity to control their water supply, and thus tend to unite the water and land interests. In addition, it is stated that the California districts are supplying themselves with water at half the price the private corporations charge, and if this is and remains true, the law seems to need no further justification. The benefits resulting from the investment of large sums of capital in irrigation works should not be forgotten, nor should the evils, which are too often an an accompaniment. The interests of the large land and water owner have probably had more than their share of attention, and it is now the small farmer's turn.

THE word "gauge," so much used in engineering and technical literature generally, will hereafter be spelled "gage" in the columns of this journal, following the authority of the Century Dictionary and the usage of the Century Magazine. We advise all our readers to go and do likewise.

The Proper Rolling Load for Bridges.

The diagram which appears in another column has been on hand for publication for nearly three years, or since about the time of the Bussey Bridge disaster; a fact which in passing we may commend to the attention of impatient contributors who infer that an article is rejected because it does not appear within a week or a month. It has been delayed, not because it was poor material, but because it was such good material, in order that it might appear when the attention of the profession was for other reasons attracted to the questions to which it relates.

Such reasons, we rejoice to say, have not come up once during this whole period, for the most likely cause, if not the only one, for keen interest in the question of the strength of bridges is some serious disaster resulting from the weakness of a bridge. We are unwilling to delay the publication of so instructive a diagram any longer, however, and perhaps it is just as well that it should appear when it can have cool and calm consideration on its merits without there being any extraneous cause to add for the moment to its inherent weight.

The basis on which the diagram was constructed is given with sufficient fullness in another column. The diagram gives the complete shipping weights for iron bridge spans of any length up to 210 ft., including all-iron floors under four different specifications for rolling load, and it also gives the equivalent live load per foot of track for chord stresses for each. It needs but a glance at the spacing of the diagram to see what a great increase in rolling load is obtained by adding a comparatively trifling percentage to the weight of the structure.

The diagram also records a curious and striking historical fact which should not be forgotten. Within the brief period of 12 years covered by it the four different rolling loads shown have each been the MAXIMUMS OF CURRENT PRACTICE, and since the last date on the diagram that maximum has still further, though but slightly, advanced. The Cincinnati Southern mogul specifications of 1875 (with 1,820 lbs. rolling load) were considered as giving a pretty good solid bridge; many iron bridges and nearly all wooden bridges were not adapted to so heavy a load. These bridges were hardly built, and the road was not opened, before the use of consolidations became imperative even on that road, and the bridges needed strengthening; but the Erie consolidation specifications of 1879 (2,240 lbs. rolling load) were considered as giving a bridge which was strictly first class, and amply equal to all probable demands.

Hardly were these specifications established as the maximum of practice when consolidations began to grow in size, and what was worse, very heavy passenger engines, with 60,000 to 70,000 lbs. on four drivers began to be common. The result was the "typical consolidation" specifications of the Pennsylvania R. R. (1883), with 3,000 lbs. rolling load specified, though 2,900 lbs. is used as the equivalent load for constructing the diagram. These specifications provided that the maximum strains which could arrive from three different types of locomotives must be provided for. This was almost immediately accepted as a proper maximum for first class bridges, but only four years later, when this diagram was constructed or at the end of 1887, the decapod had come upon the stage, and also much heavier coal cars; and it had already become clear that even the "typical consolidation" specifications must be extended to cover the actual practice of many roads.

Hence what was then the imaginary decapod rolling load, followed by a rolling load of 3,600 lbs. per lin. ft. for constructing this diagram, was assumed as a load which had evidently "come to stay," and was likely before long to be embodied in actual specifications. At that time it would have been impossible to predict what road would actually make this departure, but a sufficient evidence that it was a reasonable assumption is that one of our leading roads is at this moment contemplating the adoption of a still heavier rolling load, viz., a "typical" decapod with 161,000 lbs. instead of 135,000 lbs. on the drivers, or 32,200 lbs. instead of 27,000 lbs. on each driving axle. Our information is that bridges computed for this rolling load are likely to be soon ordered.

Why should they not be? If there is anything which the diagram on another page seems to prove beyond question it is that it is false economy to build bridges as light as even the heaviest rolling loads now in general use require, at least on roads of considerable traffic. This is more particularly true for the shorter spans, say 100 ft. or less, where the extra weight of metal required to sustain about a 20% heavier rolling load ranges only from 3% or less for 20 to 30 ft. spans up to 8% for 100 ft. spans. These additional weights, moreover, do not by any means imply an equal addition of cost, for in a weight way the percentage of increased cost is only some two-thirds as much, at most, as the percentage of increased weight.

For the benefit of those who prefer the precision of figures in such matters to the bird's-eye view which a diagram affords, we give below a table showing the percentage of increase in weight which results from specifying a heavier instead of lighter rolling load for all spans between 20 and 200 feet. This table shows :

1. The percentage of increased weight which results from using any one of the heavier rolling loads instead of the lightest (mogul) loading ; a loading which was the heaviest of fifteen years ago.
2. The percentage of increased weight which results from advancing the assumed rolling load one step, *i. e.*, from the consolidation to the typical consolidation, or from the latter to the decapod.

TABLE OF THE PERCENTAGES OF INCREASE IN WEIGHT DUE TO ASSUMING HEAVIER ROLLING LOADS.

Span C. to C. end pins.	Percentage of increased weight due to an increase from Mogul loading to			Percentage of increased weight due to increase from	
	Consolidation.	Typ. Consol	Decapod	Consol. to typ.Consol.	Typ.Consol. to Decapod.
20	0.7	1.5	2.1	0.8	0 5
30	1.0	2.3	5.4	1 2	2.9
40	1.4	3.1	7.1	1.6	3.8
50	1.6	3.7	8.7	1.9	4.7
60	2.0	4.5	10.4	2.4	5.3
70	2 3	5 2	12.1	2.7	6.2
80	2.7	5.8	13.6	2.9	6.9
90	3.0	6.4	1 .2	3.2	7.6
100	3.4	7.2	16 7	3.6	8.1
110	3.6	7.8	..	3 9	..
120	3.9	8.3	19.6	4 2	9 3
130	4.1	9.2	21.1	4.6	9.8
140	4.4	9 6	22.4	4.8	10.4
150	4 7	10.2	23 7	5.0	10 9
160	5.0	10.9	25.1	5.3	11.2
170	5 4	11.3	26.5	5.4	12.0
180	5.6	11.7	27.8	5.6	12.6
190	5.8	12.5	28 7	5 9	12.9
200	6.0	13.0	30.3	6.2	13.2

The real question in most cases, of course, is whether to advance the specified load by one step, since few roads are likely to jump at once from the lowest to the highest rolling load. The largest single jump shown in the diagram is that to the heaviest rolling load of all. Why should this not be made by any road which has already risen up to the "typical consolidation" loading ?

Since the average span on the average railway is certainly not over 100 ft. the average increase of *weight* due to the decapod loading may be seen from the above table to be about 8%. The average increase of *cost* we have already stated to be only two-thirds as much at most, which is arrived at as follows:

The cost of bridges per pound is far from fixed for all classes of structures, and varies much from year to year, but may be said to be made up as follows:

	Cents per lb.	Per cent.
1. Raw material, rolled and plate iron	2¼ to 3	50
2. Work on same in shop	¾ to 1¼	17
3. Transportation by rail	⅛ to ¼	5
4. Falseworks and erection	½ to 1	13
5. Profit and administration	⅝ to 1¼	15
Total	4 to 7	100

The lowest of these prices are sometimes cut under, especially in dull times and for large orders of a simple class of work. For example, on the Manhattan Elevated Ry., involving immense weights of a very simple class of work, contracts were let at 2 to 3 cts. per pound while on the other hand, fat contracts at much higher rates than those given above are not uncommon: but these estimates, made some years ago, are still fair averages for average work in moderately good and bad times.

It will be seen that only Items 1 and 3 above (55 per cent. of the whole), and not always even those, increase directly with the weight of the bridge. We may say in a general way that only 60 to 70 per cent. at most of the cost of a bridge varies directly with the weight; or, assuming 67 per cent., 10 per cent. more weight means 6.7 per cent.

more cost, and 8 per cent. more weight, 5½ per cent. more cost.

What is gained by this increase? There is in the first place a gain which it is impossible to estimate in dollars and cents, but which is yet a very important one; a great increase in the strength of the structure in cases of derailment or other accident on bridges, which might well be enough to save the structure and the train on it from destruction. Partial insurance against this danger is worth a considerable sum to any road, which we will not attempt to estimate.

There is in the second place a certainty that the bridge will be stiffer under load, and hence deteriorate less from the effects of continued vibration, and last longer. This advantage also is worth something, but we will not attempt to estimate, since in this respect alone the money gain is small, owing to the long period of years in which the money is invested at compound interest before the returns come in.

There is in the third place something like a reasonable certainty that the loading will at last prove heavy enough for a goodly period of years at least, since there must be some limit to the increase in rolling load, and it would certainly seem as if the decapod loading followed by 3,600 lbs. per lin. ft. came pretty near to this. But nevertheless the history of all our earlier iron bridges has been that they were taken down (or ought to have been) long before they were worn out, because designed for too small rolling loads.

Finally, there is the diminution of danger of failure of the bridge from some undetected defect of detail or of material in the structure; in other words, there is a greatly larger factor of "safety" in the structure, which we need not say is a very handy thing to have at any reasonable cost.

To gain all this, what is paid? Say 5 per cent. more in the cost of bridges, which at 6 per cent compound interest will become 10 per cent. in 11 years, 20 per cent in 22 years, 40 per cent. in 33 years, 80 per cent. in 44 years, and enough to renew the structure in about 50 years. If, therefore, the lighter specification could be counted on to give an *equally good* bridge during 50 years, but with the disadvantage that it would then have to be renewed, the balance would be about equal between the heavier and the lighter specification; but to the extent that the heavier bridge is a better and a safer one during that 50 years; to the extent that the rate of interest is likely to be less than 6 per cent. during that period, and to the extent that a better and safer bridge is valued for reasons of humanity, apart from the money profit in it, there is a clear unbalanced advantage in having the heavier bridge.

We realize fully the natural reluctance of railway managers to invest money in this way at compound interest. There is a natural and not altogether blameworthy tendency to look only to the present, and let posterity take care of itself. But when the question is looked at from every point of view, is there not a real and substantial gain which is worth paying something for from the very moment the bridge is built?

Certainly this is so in the case of bridges built to the two lighter specifications, which are still not a little used. In their case there is a practical certainty that within a very few years they will prove too weak for use, while the additional weight and cost from building them to heavier specifications will be seen from the diagram to be very trifling.

Rapid Transit for New York City.

With the appointment of a new Rapid Transit Commission by Mayor GRANT comes the usual crop of suggestions as to routes and methods of construction. The subway plan seems to be the favorite now as opposed to elevated roads, and the commission already has before it the familiar plans for the Broadway and Elm St. subways and one submitted by Mr. GREATHEAD, of London, for a deep tunnel, excavated through rock or by the shield so successfully used in the Southwark and St. Clair tunnels. The inherent difficulty in the Broadway tunnel plan is that the 40 ft. available there does not afford room enough for the four-track rapid transit road required by modern conditions of New York traffic, and, in addition, the proper arrangement and disposal of pipes, electrical wires, etc. This space under Broadway has been carefully figured out on numerous subway plans, we know; but four tracks on 32 ft. and two 4-ft. spaces for the pipe and wire disposal, present and to come, will certainly not meet the pressing demands upon such a road now, and the possible development of the near future.

But if our new rapid transit system is to materialize in the form of a tunnel, the deep tunnel plan has features well worth studying. The Broadway plan always has been, and probably will indefinitely be bitterly opposed by property owners, and the inauguration of any subway on that line is likely to be long postponed, if ever built at all. Real estate, 100 ft. or more below the surface, is less valuable; and the tunnel route need not necessarily be confined to street lines. This is an advantage in several apparent ways, and to this must be added the further advantage that its construction, and all consequent obstructions and nuisances, would be removed from the surface of a highway teeming with traffic.

The doubtful feature in the deep tunnel plan is that we know little about the real character of the ground to be penetrated. Mr. HEMAN CLARK, in suggesting a similar tunnel several years ago, based his estimates upon the experience gathered in the Croton Aqueduct tunnel, and especially in that portion driven under the Harlem River. In passing beneath a bad fault underlying the Harlem basin, a depth of 307 ft. below city datum was reached, and at that point at least the rock was so dry that it is said that the heading was "dusty," and water had to be introduced for drilling purposes. The rock was also practically dry at 100 ft. below datum, until the narrow fault was reached, and it would not have been impossible to pass this fault for ordinary tunneling purposes. This is the only actual tunneling test of the rock underlying upper New York, but the experience gained there is not unfavorable. The presence of any quantity of water in a deep tunnel, and the consequent permanent expense for drainage would be a serious addition to the maintenance account. But even this can be obviated by a metal lining, as we believe Mr. GREATHEAD proposes for such cases. The decreased cost of construction through solid rock, or even through soil by the shield method, as compared with the risk and practically unknown cost of a subway down a street lined by property representing millions, would go far toward providing for tunnel lining, shaft sinking, elevator service and other features incidental to a deep tunnel. To the passenger, while in the tunnel, it makes no difference whether the roof of the tunnel is 5 ft. or 105 ft. below the street surface, and ventilation, tractive power and lighting would be the same in either case. Adequate elevator service, to reach the tunnel, is a detail of permanent cost easily estimated, and as far as the passenger is concerned, it would be better than the present climbing of stairs to an elevated road.

Capital can easily be secured for any scheme of rapid transit in New York that has an unquestioned right of way and proper engineering endorsement. And when we consider the difficulty of fixing upon a surface route, and of adjusting the many conflicting interests inherent in the surface, a scheme that practically dives under all this trouble has a point in its favor to start with that calls for the most careful study and comparison with other projects. The entire separation of the rapid transit problem from the equally troublesome one of pipe subways on Broadway would have the advantage of leaving the latter subways to be handled in the manner best adapted to present and future service, as was pointed out in our last issue.

Since writing the above an interview with Chief Engineer BIRDSALL has appeared, which substantially corroborates what we have said as to the advisability of abandoning Broadway for any rapid transit subway scheme and separating this feature entirely from pipe subways and practically separating the latter from drainage problems. Mr. BIRDSALL says that in the neighborhood of Canal and Broadway there is a quicksand of unknown depth 15 ft. below the surface, and no estimate can be made of the cost or danger of passing it with a deep subway. This danger applies to both rapid transit and drainage subways, but not to shallow pipe subways, and is a strong argument for the working out of these three problems on distinct lines. The pipes at cross streets now in place would interfere to some degree with the subway near the surface; but it is no difficult engineering feat to lower them so that their tops would be 8 ft., say, below the surface. The fuller detail that has lately appeared for a deep tunnel scheme adds but little to what we have already said on that head, excepting that estimates of cost are now added. And it is one of the good features of this plan that its cost can be estimated within reasonable bounds; whereas no engineer can figure the possibilities of the surface subway scheme for Broadway, as Mr. BIRDSALL well points out.

CORRESPONDENCE.

Weir Formula Exponents.

LAKE CHARLES, La., Dec. 17, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: May I intrude upon your sanctum long enough to state a case and ask for your opinion. It is well-known, I suppose, that fractional exponents in formulas for the strength of columns, etc., are going out of use, especially such exponents the terms of whose fractions are large. Is it not true that fractional exponents whose terms are large always arise in consequence of an attempt to account in the expression, or by the exponents, for quantities properly accounted for in other ways?

For example, Mr. J. B. FRANCIS uses the exponent $\frac{147}{100}$ in a formula for the flow of water over weirs, etc But it is found that (see DOWNING'S Hydraulics, Part I pp. 73-4) by doubling the amount deducted from the length of the overflow and writing $\frac{150}{100} = \frac{3}{2}$, in place of $\frac{147}{100}$, the formula "agreed most nearly" with all Mr. FRANCIS experiments. If you think this is news, and I believe it is, I would be glad to have you publish it.

Yours truly,

P. H. PHILBRICK.
Late Prof. Civ. Eng., Iowa Univ.

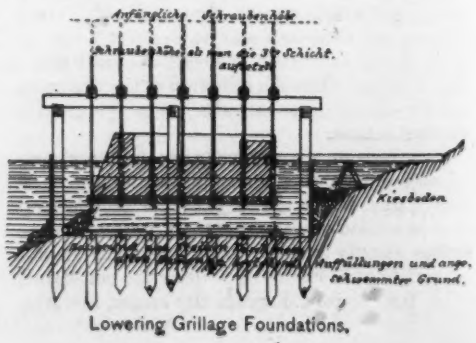
[The coefficient $\frac{3}{2}$ is employed throughout Prof MERRIMAN'S Treatise on Hydraulics, one of the standard works on the subject. ED. ENG. NEWS.]

Lowering Grillage Foundations.

PITTSBURG, Pa., Dec. 23, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Dec. 20, page 551, mention is made of a paper read before the Engineering Association of the Southwest by Mr. A. V. GUDE, of Atlanta, Ga., describ



Lowering Grillage Foundations.

ing the building of a pivot pier for a draw bridge over the Yazoo River on the line of the Georgia Pacific R. R., by means of lowering the grillage with its super-imposed masonry, upon the pile foundation with screws, suspended from crossbeams above.

In the discussion following the reading of this paper MR. JOHN MCLEOD, of Louisville, Ky., referred to a similar construction adopted by him in sinking foundations for some bridges on the Chesapeake & Ohio R. R.

If either of these gentlemen make any claim for novelty or originality in the methods described, they are certainly mistaken, for as long ago as 1814, this process was resorted to by J. R. HUERSCH, Civil Engineer in charge of the construction of a bridge over the river Aar, near Aarau in Switzerland, a very full and interesting description appearing in the *Weiner Bauzeitung*, for 1845, from the illustrations of which I have copied the sketch enclosed.

OLD TIMER.

[While indebted to our correspondent for the illustration sent us, we do not for a moment suppose that either of the gentlemen referred to laid claim to any originality of process. They simply described their individual experience in handling an avowedly old process.—ED. ENG. NEWS.]

Mules on Gravity Railways.

SYRACUSE, N. Y., Dec. 16, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The cosy way in which the horses make the return trip upon a California tramway, as illustrated on page 523 of your last issue, is certainly quite a novelty to modern minds, but it is a pretty ancient idea notwithstanding.

In MAY, 1830, Prof. BENJ. SILLIMAN made a journey to the then recently developed Mauch Chunk coal mines in Pennsylvania. His account of the trip and description of the methods and appliances for mining and handling the coal are printed in Vol. 19 of *Silliman's Journal* (Jan., 1831). It is a very interesting article and well worth reprinting entire. After describing the mine at the Summit, and the gravity railroad over which the coal was transported to the river at Mauch Chunk, the general grade of which he states at 100 ft. per mile, he speaks of the return trip, and discusses the motive power employed upon the road, the loaded cars running down by force of gravity. He says:

The empty wagons are drawn back by mules; 14 wagons to 8 mules; 28 mules draw up 42 coal and 7 mule wagons, and the arrangement is so made that the ascending parties shall arrive in due season at the proper places for turning out. The same is true of the pleasure cars which are allowed to use the railway.

The mules ride down the railway; they are furnished with provender placed in proper mangers, 4 of them being enclosed in one pen mounted on wheels; and 7 of these cars are connected in one group, so that 28 mules constitute the party, which, with their heads all directed down the mountain, and apparently surveying its fine landscapes, are seen moving rapidly down the inclined plane with a ludicrous gravity, which, when observed for the first time, proves too much for the severest muscles.

They readily perform their duty of drawing up the empty cars, but having once experienced the comfort of riding down, they appear to regard it as a right, and neither mild nor severe measures, not even the sharpest whipping can ever induce them to descend in any other way.

The return of the traveler, in the pleasure cars, is so rapid that it is not easy entirely to suppress the apprehension of danger; we performed the 8 miles from the summit in 33 minutes.

Such were the ideas of fast railway travel in 1830.

H. W. CLARKE.

[We might have mentioned this early instance of treating mules as passengers downhill and locomotives up hill, and to the admirable account which our corrospondent quotes we can add the historic fact that the mules plainly took the same keen enjoyment in their work as boys take in coasting down hill, regardless of the labor of climbing up again. They crowded into their cars at the top of the hill with the greatest eagerness, and in that and other ways showed that they regarded the whole performance as nothing more than a gigantic coasting sport.—ED. ENG. NEWS.]

A Collision Due to Curvatures.

HIMRODS, N. Y., Jan. 1, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: A head collision occurred on the Northern Central Railway at this place on the afternoon of Dec. 25, badly damaging both engines, which were heavy 10-wheelers. The collision occurred just at the end of a 3° curve and would have been avoided if there had been a tangent in place of the curve, as both trains were running not over 8 miles per hour. The cause was a misunderstanding of orders, which were not very clear. All trainmen escaped injury by jumping from their trains; 4 flat cars were completely demolished and 15 or 20 disabled. C. L. B.

[While a tangent in place of a 3° curve might doubtless have saved this accident and many others like it, the important question for the engineer is: Would a 2° in place of a 3°, or a shorter 3° curve have made it sensibly less likely, or slightly longer or sharper curves any more likely?—ED. ENG. NEWS.]

Panel Concentrations Due to Engine Loads—Correction.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: By the omission of one formula and the repetition of another the point of my last is obscured. It should read

"Now simply state this principle and we have for panel point c

$$M_c = M_a + (R_1 + R_2 + R_3 - R_4 + R_5)\, l_2$$

or generally

$$R_5 = \frac{M_c - M_b}{l_2} - (R_1 + R_2 + R_3 + R_4)$$

while for equal panels, according to Mr. SZLAPKA,

$$R_5 = \frac{M_c}{l} - (5R_1 + 4R_2 + 3R_3 + 2R_4)$$

This is literally all there is to Mr. SZLAPKA'S elaborate mathematical discussion which Mr. MARBURG praises so highly. The only difference is that it holds for any panel lengths, is simpler and requires less figures. It is self-evident."

The second formula was omitted and the third given twice, which renders the point obscure. D.

Railway Signals.

RAHWAY, N. J., Jan. 2, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have read with considerable amusement in your issue of Dec. 20 a letter from Mr. O'DONNELL, who knows, something about English signaling, in criticism of a paper read by Mr. SOULE, who knows something about American signaling. As I have the good fortune to know something about signaling on both sides of the Atlantic I feel it my duty to call the attention of both gentlemen to the following facts:

Mr. HENRY JOHNSON introduced the Dwarf indicator for use in signaling two or more diverging routes in the year 1882 on the T. & Y. Ry. This same signal was simultaneously introduced in America by Mr. C. R. JOHNSON who was then Signal Engineer for the U. S. & S. Co. In 1885 the Dwarf indicator in America gave place to MR. H. JOHNSON'S Multiplex Selector which, since that time, has been in general use here. Mr. O'DONNELL will, therefore note that we are not, as he supposes, still using the old arrangement. Mr. O'DONNELL is in error in supposing that he was the first to use the term "Selector" in connection with this class of mechanism. Mr. JOHNSON used that term in connection with the introduction of his device, as I can readily prove.

Mr. O DONNELL is under the impression that we have to run rod connections from the switches and the selectors, and consequently that placing the selectors in the downright connections is more economical.

He will be interested to learn that the selector simply makes its connection with the ordinary switch rods in passing, and that our way is therefore cheaper than his. The application of Mr. O'DONNELL'S selector scheme and some of the London signals is of quite recent date. The honor of first using "selectors" must therefore be awarded to America.

It would be interesting to hear from Messrs. SAXBY & FARMER in criticism of the new signaling arrangements at Waterloo Station. Respectfully,

ARTHUR H. JOHNSON,
Signal Engineer.

The Wanamaker Car Scale.

INDIANAPOLIS, Ind., Dec. 30, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Dec. 13 you published an article in reference to the Wanamaker car scale, and after reading it we conclude that you do not fully understand the construction and workings of the invention. Before the publication of this article we sent you cuts and description of the scale to show its workings and adjustment in detail, and its appearance on a freight car. At the same time we wrote you a letter, in which we called your attention to the importance of the *technical* description as given you being adhered to in any publication of the same you might make. We believe that if the cuts and description sent had received your careful attention you would not have commented on the device as you have done in this article. Your first erroneous statement is as follows:

1. When it is desired to weigh the contents of a car the fulcrums of the scale levers are lifted by four hydraulic jacks so that the weight of the car body is carried on the scale levers. The gross weight is then determined on the scale beam placed at the center of the car.

The fact is, the weight shown on the scale beam is the *net* weight, and cannot be anything else, as the scale is balanced by the car body, and the reading of the weigh beam must be the weight of the load or contents of the car.

2. Next you say: "When the scale is not in use the weight does not come on the scale levers, so the knife edges do not become worn."

While it is true that when not in use the levers do not carry the weight of the load, at the same time, if the knife edges were even carrying the weight of the levers, it would not be long until, with the motion of the car, even this weight would ruin the knife edges for the purpose of weighing accurately. An examination of the description sent you will show not only that the knife edges do not carry any weight, but that they are absolutely not even in contact with anything when the scale is not in use.

3. Again we quote from your article as follows:

No doubt it would be a convenience to traffic departments to be able to determine the weight of a freight car's lading at all times and places; but the urgency of the case would hardly warrant the attachment to every freight car of a system of scale levers of 30 tons capacity.

This is a very important question to us, but in answer to an inquiry made of more than a hundred prominent officials of railways in freight departments (all well qualified to answer the question) as to the per cent of tonnage that they consider their lines are hauling, for which they receive no revenue—on account of overloading and underbilling—we find that the lowest estimate that any of these officials have made is 10%, which amounts to 2 tons per car; we conclude that a means for obtaining revenue for hauling this amount of freight is a very urgent matter and warrants the attachment of this scale to freight cars.

For further evidence of the large amount of freight railways are hauling for which they do not receive any revenue on account of overloading cars, allow us to call your attention to the various expensive Joint Weighing Associations organized by the railroads at the large railroad centers, and to refer to the report of one of the division inspectors located at one of the largest railroad centers in the West, and considered a model division of this service. The report shows the following result:

Total number of cars weighed, 1889	30,733
Revenue gained	$76,574.22
Average excess per car of all weighed	5,261 lbs.

The number of cars weighed represents about only 7% of the total number of cars hauled by the roads composing this division. This is a startling exhibit, but the official report is in our hands and open for your examination. Does not this demonstrate the urgency of the case, and warrant the attachment of the scale? If it will remedy this, does the weight or cost as hereafter stated, cut much of a figure in the question of gaining revenue for this enormous amount of freight which is now hauled for nothing, besides preventing the accidents and delays incident to overloaded cars?

4. Finally, quoting your article as follows:

The inventor omits to state the net cost of his device, but hydraulic machinery is not especially inexpensive, and his scale levers will require a good many pounds of iron. In fact, the additional weight which the scale would add to every car would amount to considerably more on the average than the extra weight of freight in overloaded cars whose haulage the invention is to save. The inventor who would devise a successful weighing apparatus for attachment to every freight car must secure extraordinary lightness and cheapness first of all.

Permit us to say that we have reached a point in the manufacture of this scale whereby we are enabled to place the scale on the car complete at a cost of $100 to the railroad company, which will leave a liberal margin of profit to our company. Taking the average mileage of a car, the scale will pay for itself in one year by gain in revenue effected by its use, on any class of freight. The scale will last for 20 years. The apparatus complete will weigh something less than 900 lbs., with a capacity to lift and weigh 100,000 lbs. by a simple movement of the hand for two minutes.

If there is any other method that is so inexpensive as hydraulic jacks to lift such a load in so short a time and then return the load to its normal bearings immediately, we do not know of it. For more than two years it has been the patient work and study of the inventor of this scale to produce an accurate weighing apparatus to attach to freight cars, having constantly in mind, that to be useful it must be a substantial, simple and perfect working device, with the element of wear eliminated to the fullest extent, knowing that if it was cumbersome or heavy, or interfered with any other appliance to freight cars it would be impracticable; but to be of valuable use to railroads it must be strong, efficient and lasting. We consider that the weight and cost of this scale demonstrates that we have produced a successful weighing apparatus for attachment to freight cars, of extraordinary lightness and cheapness.

THE WANAMAKER CAR SCALE CO.

[Our correspondent's points may be answered in succession as follows:

1. The gross weight is what is actually weighed, though the net weight is what is read from the scale. It goes without saying that the scale would be so constructed as to deduct the constant weight of the car from the weight read.

2. Our phrase, "the weight," includes of course the whole weight carried on the knife edges,

3-4. The actual records of weighings quoted are of much interest. They show a saving in freight collected of $2.48 per car from weighing 7% of the cars. We may not unreasonably assume, however, that this 7% included about all the cars which there was much chance of finding to be overloaded, which would indicate that $17.36 per 100 cars would be recovered at one weighing. The scales for these 100 cars would represent an investment of $10,000. If they last 20 years (which seems to us a very liberal estimate), $370 per year must be set aside at 3% compound interest, to renew these at the end of that time.

There is in addition a proper interest to be earned on the permanent investment of $100 per car, even if we prove the scale to last forever (as we make it do by charging against it the above $3.70 per car). Now, no prudent manager would go into an investment of this kind, unless he thought he saw at least 10 per cent. per year in it, or $1,000 per year per 100 cars. There is in addition the cost of hauling about the extra 900 to 1,000 lbs. per car, and of current repairs to it, apart from renewals. A very low estimate for both of these items (if not for either one of them), is 0.1 cent per car mile, or for 15,000 miles per car per year, $15 per car, or $1,500 for 100 cars. Therefore, the total cost per 100 cars per year will be $370+$1,000+$1500=$2,870 per 100 cars. Against this we have the evidence that $17.36 per 100 cars is likely to be saved in one weighing, from which it follows that $\frac{2870}{17.36}$= 165 such weighings per year must be made, not merely to make the scale "pay for itself in one year," but to keep it going on a paying basis. Can this be done? We fear not. We have no disposition to throw cold water on new enterprises of any kind, but it is always well to face facts. If any serious error in the above computation can be pointed out to us, we shall have pleasure in conspicuously correcting it.—ED. ENG. NEWS.]

Notes and Queries.

G. K. C. writes: Having been a constant reader of your most valuable paper for several years past, I take the liberty of making the following request: Will you kindly give me names and addresses of parties, both engineering and contracting, operating in South America or Australia, with a view of opening a correspondence relative to obtaining a position with them.

[If our correspondent will think the matter over, he will see the unreasonableness of this request. He might more reasonably ask us to make a list of all those in the United States who might possibly be able to offer him a position, since his chance with each one of them would be much greater than with each name on the foreign list.]

SUPERIOR asks: Can you tell me the name of any firm who build retorts or crematories for burning garbage, etc. I believe some of the larger cities employ this method to get rid of theirs and I would like to build a small one for the same purpose.

[The largest American garbage burning works are at Buffalo, N. Y. Something has been done in the same way at Rochester, N. Y., if we remember correctly. The largest and most successful works in the world are at Leeds, England, and have been fully described in these columns, as also the Buffalo works.]

Geographical Distribution of the American Society of Civil Engineers.

With this issue we present a skeleton map of the United States, showing the distribution, by States, of the voting membership of the American Society of Civil Engineers. We published a similar (somewhat larger) map July 1, 1887, but that map showed members of all grades.

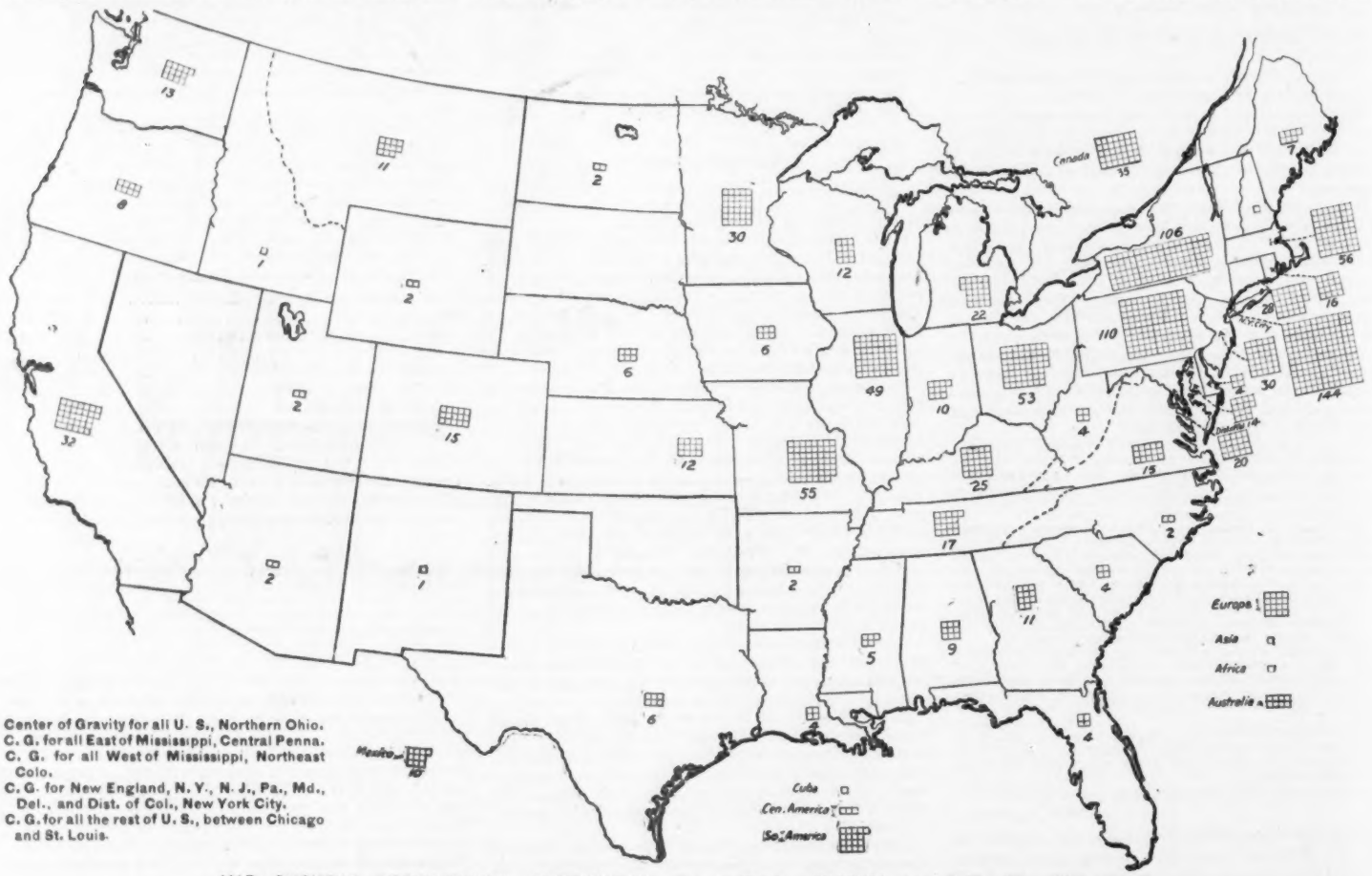
Except in the case of New York City, no attempt has been made to indicate the exact residences of the several members within their several States; but in each State where there are voting members is drawn a group of small squares, one square for each member residing within that State according to the published list of members for 1890. In the case of New York, the city membership of 144 is shown separately from that (106 members) of the rest of the State.

A few members, having residence in one State and place of business in another, appear twice in the list of States; and as our map follows that list it therefore shows a membership somewhat (15 members) in excess of the truth; viz., 1,080 instead of 1,065 members.

The list, and the map constructed from it, show the main distribution to be as follows:

Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland and District of Columbia, 528 members, center of gravity assumed to be in New York City. All the rest of the continent shows in the map 505 members with center of gravity between Chicago and St. Louis. The Virginias, Carolinas, Kentucky, Tennessee, Georgia, Alabama, Mississippi and Florida, 96 members; Ohio, Indiana, Illinois, Michigan and Wisconsin, 146 members. All these States and provinces east of the Mississippi river, 812 members altogether, have a center of gravity in central Pennsylvania. Mexico and all the states west of the Mississippi river, 221 members have their center of gravity in the northeast corner of Colorado. The entire district represented by the map, 1,033 members, has its center of gravity in northern Ohio. In addition Cuba and Central and South America hold 21 members and the old world 26, making 1,080 in all, 15 of which are duplicates, as above explained.

It will be seen that it is not without reason that St. Louis and New York are the centers of origin of opposing tickets. They are the centers of gravity of nearly equal opposing masses of members, the one consisting of the members residing in the Middle States with the three southern New England States, and the other, the rest of the members residing on this continent. We do not mean or believe, that these two masses may be expected to vote different ways. They are more likely to vote the same way; but the general distribution of the membership is interesting in itself, and as such is presented.


Canada
Europe
Asia
Africa
Australia
Mexico
Cuba
Cen. America
So. America
Center of Gravity for all U. S., Northern Ohio.
C. G. for all East of Mississippi, Central Penna.
C. G. for all West of Mississippi, Northeast Colo.
C. G. for New England, N. Y., N. J., Pa., Md., Del., and Dist. of Col., New York City.
C. G. for all the rest of U. S., between Chicago and St. Louis.

MAP SHOWING GEOGRAPHICAL DISTRIBUTION OF VOTING MEMBERS OF THE AM. SOC. C. E.

The Porosity and Permeability of Cement Mortars and their Decomposition by Sea Water.

In the September number of the *Annales des Ponts et Chaussées* is an exceedingly full paper entitled "Experimental Researches upon Hydraulic Mortars," by M. PAUL ALEXANDRE, chief engineer *Ponts et Chaussées*. The original text covers 158 pages of an octavo volume and deals in the selection of material, making and treatment of briquettes, the influence of sand, water and temperature, etc., on the cements. Out of this mass of matter we have selected the results of the experiments coming under the head above given.

Commencing with the *resume* on the porosity of mortars, M. ALEXANDRE in substance says: After having remarked that the porosity of a mass of hardened mortar has for its measure the volume of water that it is able to absorb, we have established the fact that the voids present are the sum of (1) the

void belonging to the making of the mortar; represented by the quantity of water absorbed by the mor tar before it has taken a set. (2) The latent void, which comes in the mixing of the mortar, when the grains of cement and sand imprison a thin coating of air about them which augments the apparent volume. (3) The void resulting from the evaporation, during the setting process, of some part of the water employed.

In the preceding experiments, each of these voids was studied separately, and the attempt made to find a total void which would give the measure of the theoretical porosity. The writer arrives at the following conclusions:

The porosity of cement mortar varies widely, and the voids may be as low as 13%, or as high as 31% of the volume of the mortar. Other things being equal, the porosity of mortar diminishes as the proportion of cement increases. Between rich and meagre mortars, the mortars made of coarse sand have the best of it. Mortars made of fine sand vary in the proportion of 5 to 6, where the amount of cement is from 250 to 550 kilos. per cu. meter of sand. Other things being equal, the porosity of cement mortar increases as the size of the sand grain diminishes. Mortars made of fine sand are always very porous, even when the proportion of cement is considerable. As a conclusion, the least porous mortars are those rich in cement and made with coarse sand.

Lime mortars are, generally speaking, more porous than cement mortars, and in practice the voids vary from 23 to 31%. Other things being equal, the porosity of lime mortar seems to be almost independent of the amount of lime used; the differences are inconsiderable. The porosity of lime mortar increases in a feeble proportion as the size of the sand diminishes. Hydraulic mortars mixed *dry* are more porous than those mixed wet, and the porosity varies according to the degree of moisture used.

As to the permeability of mortars, the author speaks as follows: In the original experiments the relative permeability of various mortars was measured by the duration of flow of a volume of water filtering, under a constant head, through a mass of determined thickness. From these experiments the author concludes:

Other things being equal the permeability of mortars is increased as the proportion of cement decreases; it increases with the coarseness of the sand used; mortars made with a mixture of sand of various sizes are relatively non-porous and non-permeable. The permeability of mortars submitted to a continuous filtration of soft water, or of sea water, diminished rapidly with the time. At the end of some months, all the mortars (except those of feeble dosing of cement) became impermeable under a head of 16 ins. of water; the mass of mortar being 1⅞ ins. thick. Mortars mixed dry are more permeable than those mixed wet, or of a "normal" consistency. But at the end of some months these too become impermeable.

Referring to mortar to be used in sea works M. ALEXANDRE says that the first thing to do is to make the mortar of selected sand and rich in cement. In speaking of cases in practice, the author says that he saw a sea wall at Dieppe demolished after 150 years of use. The body of the wall was masonry laid in fat lime mortar, and the facings in cut stone laid in puzzolana mortar. The latter mortar was absolutely decomposed; while the fat lime mortar was only disintegrated, for a distance of about 6 ins. in from the front and back facing walls and in the foundation. The heart of the wall remained intact and was of an extreme hardness.

The choice of cement to be used is of the first importance, and on this subject M. ALEXANDRE says: Hydraulic limes, which generally decompose when exposed to sea water, should only be used in the higher parts of the work, if used at all. On the Atlantic and Channel coast hydraulic lime mortar, made with a half volume of lime to one of sand, comes to about the same price as a cement mortar made with 300 kilos. of cement to a cubic meter of sand. The endurance of both mortars is about the same, and in such cases the cement mortar should be preferred.

In selecting cement, only those should be considered that have already proved their ability to resist sea water by use in sea works already of considerable age. The tests made during use should be practically confined to seeing that the manufacture has been regular and that no accidental deterioration has occurred since made.

The proportions of the cement mixture must be determined for each particular case according to circumstances, and whether the masonry is to be laid in water or under the protection of coffer dams etc. Under ordinary circumstances, M. ALEXANDRE gives the following proportions of cement and sand:

For pointing cements, 600 kilos. of cement per cubic metre of coarse sand. For the bottom of locks and analogous work, 500 kilos. of cement to one cubic metre of sand. The same for the foundations of walls, to a height to be determined by the amount of exposure to water during construction, and the filtration which may occur after the completion of the work. For masonry in general, 400 kilos. per cubic yard of sand, or what may be termed the normal dosage. For the higher parts of the work, commencing at a certain level, and for filling back of facing walls laid with very rich mortar, 300 kilos. per cubic yard of sand will do.

In selecting the sand to be used, all argillaceous sands should be rejected, though some of these may often be washed. Coarse sand has in it usually a certain proportion of medium and fine sand which is excellently adapted for use in this class of work. Fine sand should be rejected, even at great sacrifice, when mortar must be used in the execution of work exposed to the action of the sea during the laying of the masonry. It is often more economical to increase the coarseness of the sand rather than to add to the dosage of cement.

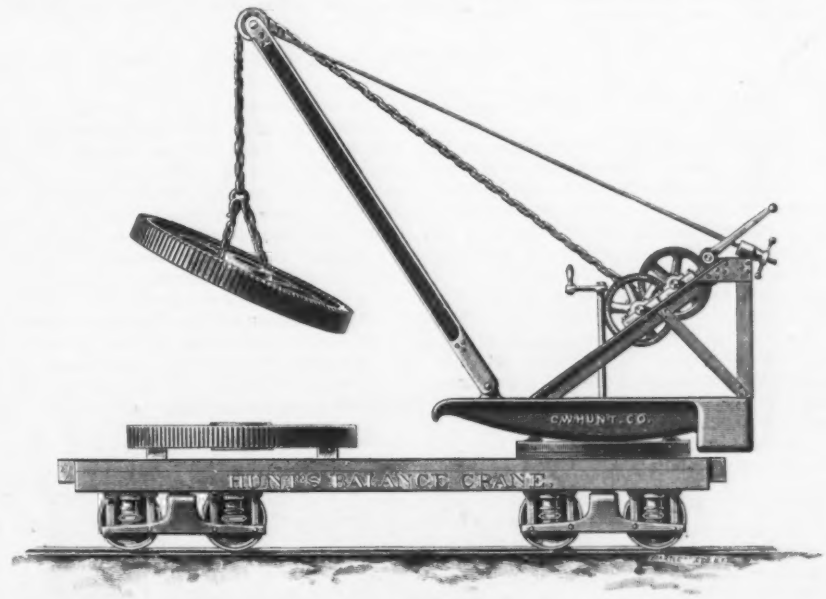
For cement mortars, M. ALEXANDRE says that fresh or sea water may be used indifferently, according as one or the other is the easiest to procure at the works. For mortars made with hydraulic lime, fresh water is usually preferred; but the author's experience on this point is not sufficiently extensive or prolonged to permit him to determine this question definitely. With mortars used in the dry or under water, the author thinks it is better to use an excessive rather than an insufficient amount of water in making the mortar.

Balancing Crane for Narrow Gage Cars.

The accompanying engraving shows a novel crane which has just been designed by the C. W. Hunt Co., of this city for use on narrow gage cars. The Hunt system of railways is designed for handling materials in and around manufacturing establishments, coal yards, mines, plantations, etc. The gage of the track is but 21 ins.; and this narrow base of support has heretofore been an obstacle to mounting cranes upon the cars, for use in handing materials, loading and unloading cars, etc., about mill yards and shops. The crane illustrated has been designed to overcome this difficulty. It is so constructed that the counterweight at the base adjusts itself to balance the load on the end of the jib, and there is no side strain tending to tip the car off the track.

The accompanying engraving shows the general construction of the car. The crane jib, with its framework, is mounted on a heavy cast iron base, made solid at the end opposite the jib to act as a counterweight. This base is curved on the under side and rests on rollers, journaled in the upper plate of the turntable by which the crane is revolved. When any ordinary weight is to be lifted the base casting remains stationary; but when the load becomes greater than the counterweight can balance, the base casting tips down in front, thus shortening the lever arm of the load and lengthening that of the counterweight. The movement of the structure is in fact similar to what would occur if the base and jib with their load were suspended from a point at a vertical distance above the center of the base equal to the radius of the curve on which the structure rolls. Disregarding friction, the center of gravity remains above the center of the base until the lip at either end comes in contact with the turntable.

While this crane was especially designed for the 21-in. gage cars of the C. W. Hunt industrial rail-



A BALANCED CRANE FOR NARROW-GAGE RAILWAYS.

way, it gives a hint well worth considering to the builders of wrecking cars for narrow gage railways, and indeed to all crane builders who have to design cranes to be supported on a narrow base.

RAILWAY TIES of Tasmanian native gum wood are to be tried in Egypt, according to a statement in *Colonies and India* (London). The Egyptian government has ordered 1,000 of these ties as an experiment. It is also proposed to try ironwood ties from Tasmania. Oak is the timber now generally used on the Egyptian railways.

THE ULSTER CO., N. Y., CEMENT WORKS turned out the following quantities in 1889, says a correspondent of the *New York Sun*, in describing the cement industry in this section:

Name.	Location.	Barrels.
F. O. Norton's	High Falls	25,907
F. O. Norton's	Binnewater	241,715
D. A. Barnhart	High Falls	70,709
James H. Vandemark	High Falls	53,840
Lawrenceville Co	Lawrenceville	129,851
New York & Rosendale Co	Rosendale	223,056
New York Cement Co	Whiteport	219,601
Newark & Rosendale Co	Whiteport	201,257
Connolly & Shaffer	Eddyville	145,103
Hudson River Co	Kingston	162,276
Newark Lime & Cement Co.	Kingston	221,896
Lawrence Co	Rosendale	61,706
Lawrence Co	Rock Locks	171,223
Lawrence Co	Eddyville	236,863
Lawrence Co	Kingston (Esopus mill)	116,518
Lawrence Co	Binnewater	265,800
Total		2,547,290

The same writer says that about 20,000 skilled and unskilled laborers are employed at wages ranging from $1.75 to $3.50 per day. He believes the output for 1890 will be nearly 1,000,000 barrels ahead of the figures given for 1889.

The 1,200-Ton Testing Machine of the Phœnix Iron Company, at Phœnixville, Pa.

(WITH INSET.)

The powerful hydraulic testing machine which we illustrate on our inset sheet and in the accompanying engravings was designed by the Phœnix Iron Co. to meet the demands of their extensive business in testing to destruction full-sized sections of the largest members used for tension and compression in structural iron or steel work.

The machine is a reproduction on a larger scale of the machine designed by CHARLES KELLOGG for the works of the Union Bridge Co., at Athens, Pa. which was described by CHAS. MACDONALD, C. E., in a paper read before the American Society of Civil Engineers in January, 1887. The principal modifications are the head block attached to the piston, which is supported by guide rods securely bolted to the main girders instead of by wheels running on a track, as in the Athens machine, and the back cylinder head, which has been added to adapt the machine for making compression tests.

The cylinder is 64⅛ in. in diameter and 6 ft. stroke. It is bolted to the main girders with 80 turned steel bolts 2 ins. in diameter. The piston rods, four in number, are 8½ ins. in diameter, leaving the net area of the cylinder just 3,000 sq. ins. when used in making tensile tests.

The pulling rods attached to the tail block are of the same size and number as the piston rods. The stop pins securing the tail block to the main girders are 9½ ins. in diameter, two through each girder.

The recoil and head blocks are provided with 10-in. pin holes, the slots being capable of receiving eyes of 30 ins. diameter and 4½ ins. thickness.

The main girders are 78 ft. long over all and 51½ ins. deep. Each has a total sectional area of 244½ sq. ins., or at the pin holes a net section of 166 sq. ins. They rest on compound plate girders bolted to masonry foundations, and are stiffened throughout their length by riveted gusset brackets, as shown. The machine is capable of receiving an eye-bar 50 ft. long from center to center of pin-holes.

This machine has been designed to work up to a duty of 2,160,000 lbs., requiring a pressure of 720 lbs. per sq. in. on the piston area; but it can with safety be worked at 800 lbs. water pressure, which amounts to a load on the piston of 2,400,000 lbs.

Steel has been used throughout in its construction, the girder work being done in the shops of the Phœnix Iron Works and the machine work by the Chester Foundry & Machine Co., in their shops at Chester, Pa.

For the drawings and information concerning this machine we are indebted to Mr. AMORY COFFIN, Chief Engineer of the Phœnix Iron Works.

The drawings on our inset sheet are general views of the machine, with details of the hydraulic cylinder and the girder. The sliding guides for the headblocks which replace the wheels used in the Athens machine seem to be an improvement, manifestly so when the machine is used for compressive tests. The details are shown in Fig. 1.

The piston, while of much smaller diameter than many low-pressure cylinders for compound or triple expansion steam engines, probably sustains a greater load when the machine is working to its full capacity than any piston ever constructed. The piston of the Athens testing machine has an area of 2,039 sq. ins., and the capacity of the machine is about 1,200,000 lbs. The testing machine at the Keystone Bridge Works was remodeled last season and has now a capacity of 800,000 to 1,000,000 lbs. It is possible that this load on the piston of the machine illustrated, 2,400,000 lbs., may have been exceeded in pistons for hydraulic presses or hydraulic forging, but it is hardly probable, since so enormous a load would be preferably divided among several pistons except in the case of testing machines,

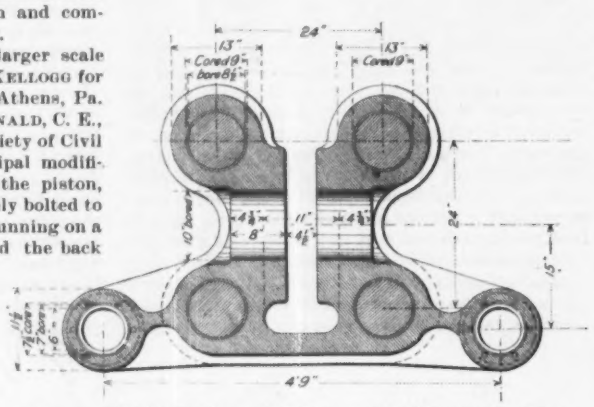


FIG. 1.—HEAD BLOCK. SECTION THROUGH PIN HOLE.

where it is desired to reduce friction to a minimum.

The arrangement of the packing on both the piston and the piston rods deserves especial attention by engineers who may be disposed to question the accuracy of the machine. The usual packing for hydraulic work where high pressures are employed is the cup-leather packing, in which a leather or rubber ring of V-shaped cross-section encircles the piston or rod. The pressure of the confined water forces this against the sides of the cylinder, thus making the tightness of the packing proportional to the pressure of the water. It was by the invention of this packing that BRAMAH, to whom is generally ascribed the invention of the hydrostatic press, achieved success where other inventors had failed.

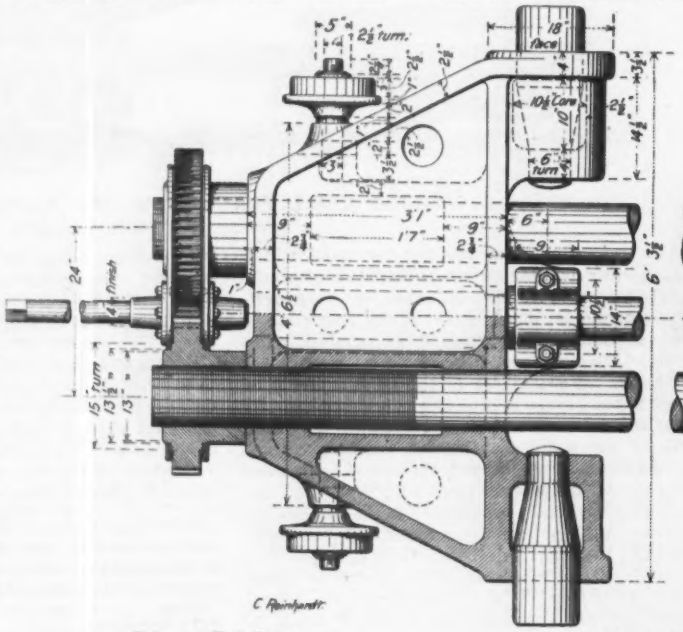


FIG. 2.—Tail Block.

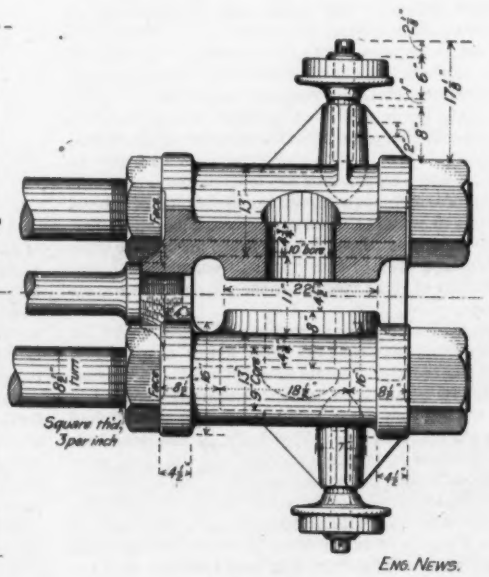


FIG. 3.—Recoil Block.

SHOWING APPARATUS FOR ADJUSTING LENGTH AND ABSORBING RECOIL IN PHŒNIX TESTING MACHINE.

But while a packing whose tightness and whose friction increases directly with the pressure is almost a necessity in ordinary hydraulic work, the rapid and indeterminate increase of friction makes it unsuited for testing machines. As shown by the drawings, therefore, brass glands surround the piston and the rods and confine several rings of ordinary flax packing. The friction of this packing is greatest when the pressure is lowest, since the increase in pressure compresses the packing and permits a film of water to escape between the packing and the walls of the cylinder. In the Athens machine, under high pressures, a thin film of water has been observed escaping around the whole circumference of the piston. The total friction of the piston and rods in the Athens machine has been determined to be less than 4,000 lbs. when the water pressure is off the machine, or hardly one-third of one per cent. of the full load of the machine. It is believed that when the pressure is on and a film of water is escaping all around the piston, this maximum friction must be greatly reduced. Mr. MACDONALD's paper, above referred to, was thoroughly discussed at the time of its presentation before the American Society of Civil Engineers, and it was pretty conclusively shown that the friction of the Athens machine was too small to seriously affect its accuracy.

The design of the cylinder covers is worthy of note in view of the enormous load which they have to sustain. The cylinder heads and piston are of cast steel. A copper wire is the only gasket used under the cylinder heads.

Besides the great size and power of the machine, its chief features of interest are the means employed for adjusting the tail block and for taking up recoil. It is hardly realized by those unfamiliar with testing machine work what a shock is caused by the breaking of an eye-bar under a strain of hundreds of tons. The stretch of the bar may be 12 per cent. or more of its original length, and the elastic metal recoils on fracture with very considerable energy.

The general design of the tail block is best shown in the plan view on the inset sheet. The pull of the eye-bar under test is sustained by four steel rods, *A A*, of the same size as the piston rods. These are held to the recoil block, *R*, by double nuts, as shown, but are free to slide back through the trapezoidal-shaped tail block casting *B*. The rod *C*, however, has to slide back through a brass box (seen in detail in Fig. 5). This may be screwed down to give any desired amount of friction on the rod to check the movement of the recoil block.

In preparing for a test the tail block is rolled along until it is opposite the pair of holes which are nearest right for the length of the eye-bar to be tested. The pins, *D D*, are then inserted, holding the main tail block casting. To adjust the recoil block to the exact position for the eye-bar, the shaft *H* is turned. This shaft carries a pinion which meshes with gears cut on the four nuts, *N N*, which hold the rods *A A*. In this manner these nuts may be screwed up or loosened until the recoil block *R* is brought into the right position to receive the eye-bar.

When the bar is in position the pump, which supplies the hydraulic pressure, is started and the bar is put under tension. Regular readings are taken of the mercury gages attached to the hydraulic cylinder, and measurements are made at the same time of the elongation of the bar between fixed points. As an interesting example of the results

attained by the machine and the behavior of large eye-bars under a breaking load we give the following results of a test, taken from the Phœnix Iron Company's records:

Test No. 6, Phœnixville, Pa., Aug. 4, 1890. Full-sized test of 10 ins. × 1¼ ins. steel eye-bar. Rolled by Phœnix Iron Co. Manufactured by Phœnix Iron Co.

Length out to out of pin holes:

Before breaking: 25.49 ft. After breaking: 30.01 ft.
Head A: Dimensions, 13.64 ins. × 1.98 ins. Excess, 46%.
Head B: " 14.52 ins. × 1.86 ins. " 46%.
Pinhole A: Diameter, 8.66 ins. Elongation, 1.56 ins.
Pinhole B: " 8.66 ins. " 1.78 ins.
Nominal section: 10 ins. × 1¼ ins. Actual section, 9.94 ins. × 1.86 ins.
Original area: 18.49 sq. ins. Fractured area, 9.65 sq. in.
Gage reading for elastic limit, 175 = 525,000 lbs.
" " ultimate strength, 310 = 930,000 lbs.
Elongation: in 12 ins., 5.06 in.; in 21 ft., 4.12 ft.
Elastic limit: 28,300 lbs. per sq. in. Ultimate strength, 50,290 lbs. per sq. in.
Elongation: in 12 ins., 42.1%; in 21 ft., 19.6%.
Reduction of area, 47.8%.
Fracture: irregular, silky.

Remarks.

Time of breaking, 30 minutes.

Elongation in each foot [along the 21 ft. length of the body of the bar where the elongation was measured]: 2.18 ins , 2 15 ins., 3.40 ins. (broke), 5.06 ins., 2.70 ins., 2.40 ins., 2.90 ins., 2.58 ins., 2.18 ins., 2.00 ins., 1.96 ins., 2.00 ins., 1.90 ins., 1.80 ins., 2.48 ins., 2.54 .. 2.06 ins., 1.80 ins., 1.78 ins , 1.90 ins., 1.20 ins.

In the first test made on the machine on June 2, 1890, a steel eye-bar 7 ins. × 2 1/16 ins. cross section showed an elastic limit of 435,000 lbs., or 30,160 lbs. per sq. in., and an ultimate strength of 786,000 lbs., or 54,500 lbs. per sq. in. The elongation in 20.437 ft. was 19.93%, and in 12 ins. it was 39.33%. The reduction of area at fracture was 46.81%.

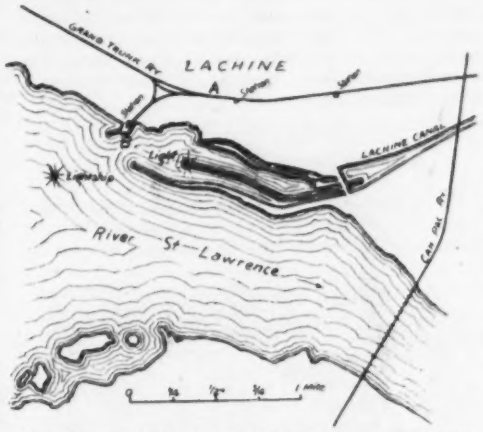
The above figures as to the tenacity and resilience of steel eye-bars of large section deserve careful attention by every engineer who still clings to the old idea that steel is a brittle and treacherous metal. Certainly a metal which stretches over 5 ft. in a length of 30 ft., as did the second eye-bar tested, has resilience enough to satisfy the most exacting.

The Lachine Railway Accident.

We give herewith a small map showing the site of the recent Lachine accident on the Grand Trunk Ry., the main facts in regard to which have been communicated to us by a Montreal subscriber, as follows:

The accident seems to have had all the elements for a great catastrophe, in which a train, generally of several well loaded coaches, might have been piled into the St. Lawrence, the driver having become conscious of something being wrong only in time to apply the brakes and go over the wharf in his engine.

The night of Dec. 3, 1890, was stormy, with a heavy snowfall. Early in the evening of Dec. 3 an accident occurred at Richmond street, in Montreal, whereby the night train to Toronto was delayed until the morning (about 5 A. M.) of Dec. 4, when it started out on about the time of the early suburban train to Lachine wharf. At the switch (marked *A* on plan) where the Lachine Branch leaves the main line the switchman mistook the Toronto train for the Lachine suburban train and switched it on to the Lachine track. The engine driver seems not to have noticed this mistake for some time after leaving the switch, as there was ample distance within



Map Showing Site of Lachine Accident on the Grand Trunk Railway.

which to stop the train between the switch and the wharf; but he applied the brakes only in time to save the train, as the engine and tender went over into the river and the baggage car projected part of its length over the wharf. The engine driver was killed, but the fireman, although carried down into the water, managed to free himself, and rising to the surface was rescued from among the floating ice by a passenger, who by means of the bell-rope pulled him ashore.

The Lachine wharf is marked *B* on the plan. The lights shown in Lake St. Louis are removed in winter. The *Y* shown between the switch and Lachine wharf is used for turning the suburban engine.

The Grand Trunk is a double track from Montreal past Lachine, in addition to having another track, shown near the Canadian Pacific Ry. line. The trouble seems to have lain in having a short stub switch running to a much-used local station on a wharf unprotected either by an operator at the junction, by which he could insure safety, or by sufficiently conspicuous distant signals to enable the engineman to take action to this end in time to save his train.

State Irrigation Commenced.

In a late report on the irrigation of arid lands, Mr. JOSEPH NIMMO, JR., special agent of the Department of Agriculture, practically recommends that the Government should grant irrigable lands to the States and allow them to construct and conduct irrigation works. This conforms with the general stand taken by the far western States, and would mean that the States benefited pay for the work, instead of scattering this cost for special work over the whole country from Maine to Texas. Mr. NIMMO advances the following arguments:

The case stands thus: These States in their Constitutions have incorporated the principle that the waters of the State belong to it, and in most instances, I think they have adopted a provision, the idea of which is that the water for irrigation purposes is for the public use. So you see, through virtue of the fact that the national Government has accepted this provision, the water belongs to the States, while the land is owned by the United States. As is well known, however, the land is practically worthless for agriculture without water. The ownership of the water is the governing condition.

Now the question arises, How will it work for the appropriations to be granted by the State while the sale of the lands is under control of the national Government? It is argued with considerable force throughout the arid region that the control of the lands, as well as the water, should be in the hands of the several States. Another point is that the irrigation of the land has its various conditions in different sections, even when they are in the same State, giving rise to many aspects of the question which should engage the legislative minds. It is regarded that it will be impossible for Congress to give these questions any sort of practical consideration. There is great force in this objection. Our people in the East know nothing whatever of irrigation, its methods, needs, and results. It appears to be a subject which must be handled by legislators personally familiar with it.

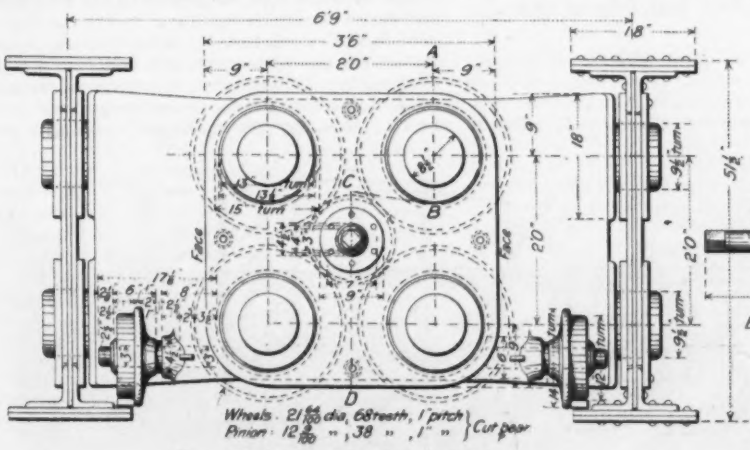
Irrigation cannot be carried on under the laws of the riparian rights which prevail in the humid areas. In arid regions the law of appropriations for beneficial uses must and always will prevail, and the laws of riparian rights, with all their consequent social and industrial aims, must be set aside. But our Eastern lawyers and legislators are only familiar with the operation of these latter laws. Congress and the United States courts, however, have recognized the appropriation laws when local custom sanctions them.

"Alium."

Mr. EUGENE H. COWLES, of the Cowles Electric Smelting & Aluminum Co., proposes the abbreviated name of *Alium* for the metal aluminum. In a letter to the New York *Tribune* he thus summarizes the pros and cons of the matter:

Five years ago the Cowles Electric Smelting & Aluminium Co. was organized. Before a month had gone by the business department began to wail for a shorter word. The unusually long name of the company was bad enough, but when a man was asked to sign aluminium fifty or one hundred times a day to letters or telegrams, the extra *i* in the word, although very beautiful, became very expensive. For on every occasion that the word was written the writer was compelled to stop and count the upstrokes and down strokes of his pen, and it cost money to telegraph the extra *i*. So the *i* was voted a nuisance and the company went to court and changed the word in its name from aluminium to aluminum. This is thought permissible, as WEBSTER allowed the second *i* to be dropped, notwithstanding that Sir HUMPHREY DAVY designatedthe metal which he suspected to exist in the earth alumina aluminium. This change has now become almost universally popular in this country.

Still the word aluminum is far from satisfactory, either to the scientists, to philologists, or to the trade. This dissatisfaction is shown by R. A. HADFIELD, a most accomplished English metallurgist, in a communication to ENGINEERING NEWS, of Oct. 29, wherein he proposes that the word "aluminon" instead of the above words be adopted. It is also exhibited in an incisive little paper which was



Gear wheels shown by dotted circles.

FIG. 4.—REAR END ELEVATION.

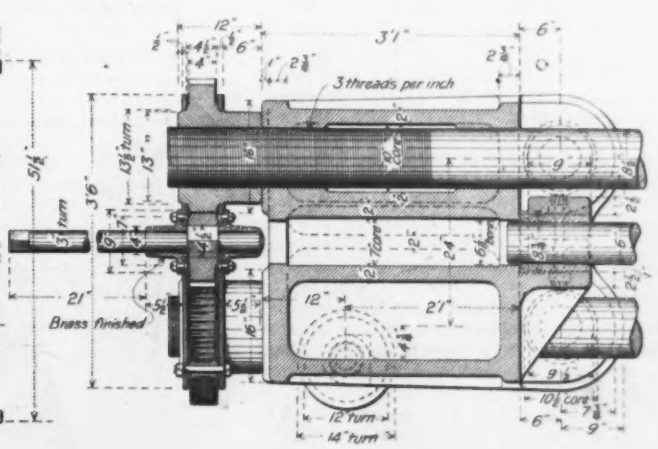


FIG. 5.—VERTICAL SECTION OF TAIL BLOCK THROUGH A B AND C D.

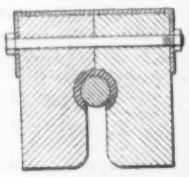
read before the Washington meeting of the American Institute of Mining Engineers by Mr. OBERLIN SMITH, entitled "Aluminum in Search of a Nickname," wherein he proposed a number of new words to take its place. Among those was the word "alium." It is to this word that the writer wishes to lend his approval, and to bring it to the attention of the public. The reasons in favor of its adoption are that it is brief enough for a household word which must soon hold its own with iron, zinc, copper, lead, etc. Its sound is so sweetly turned that we lose nothing in euphony by dispensing with aluminum. Historically it has only inserted the *i* in the ancient and honorable word, alum, the root of all these words. Chemically speaking, it contains the syllable al, the abbreviation of aluminum; while in its last syllable will be found both terminations, *ium* and *um*, which are used by chemists to signify a metal, and the change, if it could be made in the same authoritative way, should not be objectionable to the literati.

Mr. COWLES errs in one respect in the above letter, if the Century Dictionary may be trusted. Sir HUMPHREY DAVY never suggested, or heard of the word *aluminium*, but when he predicted the discovery of the metal in 1808, by analogy from his discoveries of potassium and sodium, he suggested for it, first the form *alumium*, and then, for obvious euphonic reasons, inserted an *n* in the word, giving it the form *aluminum*. Thus it remained until the metal was actually produced by WÖHLER in 1828, and he, with true German partiality for the longest form, added still another letter and syllable, and evolved *aluminium*, the only five-syllabled name of an element in the whole list. Americans have now almost universally adopted the shorter form proposed by DAVY, and that or some still shorter form will undoubtedly prevail, as the metal becomes a familiar one.

We may add that the Century Dictionary erroneously credits DAVY with the actual discovery as well as suggestion of the metal, but this error has been corrected in later editions.

The Application of Electricity to the Boynton Bicycle Railway.

The Boynton Bicycle Railway at Coney Island has been successfully operated during the past season. The road is 1¼ miles in length, with steep grades and sharp curves; but it is claimed that speeds as great as 90 miles per hour have been attained. The train consisted of one locomotive (illustrated and described in ENGINEERING NEWS, March 2, 1889), and one car. The fuel consumption from Aug. 23 to Sept. 23 is claimed to have been less than 5.7 lbs. per train-mile. About 4,500 regular trains were run over the road.



Overhead Rail and Wire for Boynton's Electric Railway.

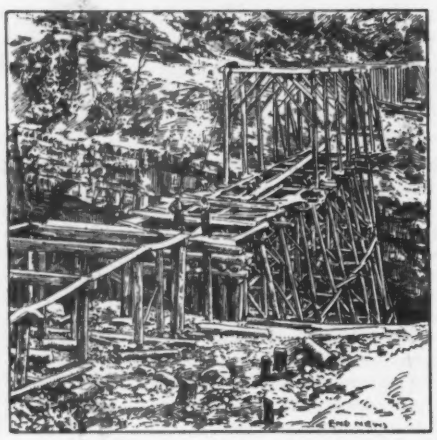
A recent and notable addition to the bicycle system is the use of electricity as a motive power. In designs recently patented the electric conductor is attached to the overhead rail and thoroughly insulated. The accompanying cut shows one proposed mode of construction of the overhead rail and conductor. The insulated wire is held between the grooved halves of the overhead rail; and after erection a cutting disk is inserted to remove the insulation on the lower side of the conductor. An important advantage of this method of construction is that the conductor is protected from snow or rain, and leakage of the current is prevented.

The bicycle railway might have been christened the single track railway with much more appropriateness. Its essential feature, as will be remembered, is the use of a single rail and the maintenance of the car in an upright position by the use of overhead guide wheels. The great advantage of this is that the resistance to motion due to curvature is almost wholly eliminated. For this reason the system seems likely to show to the best advantage when applied to local transportation lines in a rough, mountainous country. Here the narrow roadbed required would make the cost of construction very light, especially in side-hill work. The elimination of curve resistance would permit maximum grades to be somewhat increased and at the same time readily permit a large amount of development for reducing grades. The application of electricity as a motive power would save the hauling of a heavy locomotive up the grades, and in that way reduce the cost of operation.

There is a real need of a mode of transportation not much exceeding the wire rope bucket transport system in first cost, but able to carry all classes of traffic and to admit both of cheap operation and of considerable expansion with the growth of traffic. The single track or "bicycle" system seems to promise to meet this need; and it is to be hoped that some competent engineer will undertake the installation of a pioneer plant in some locality where a standard gauge railway is not feasible; but where some system of transportation is needed.

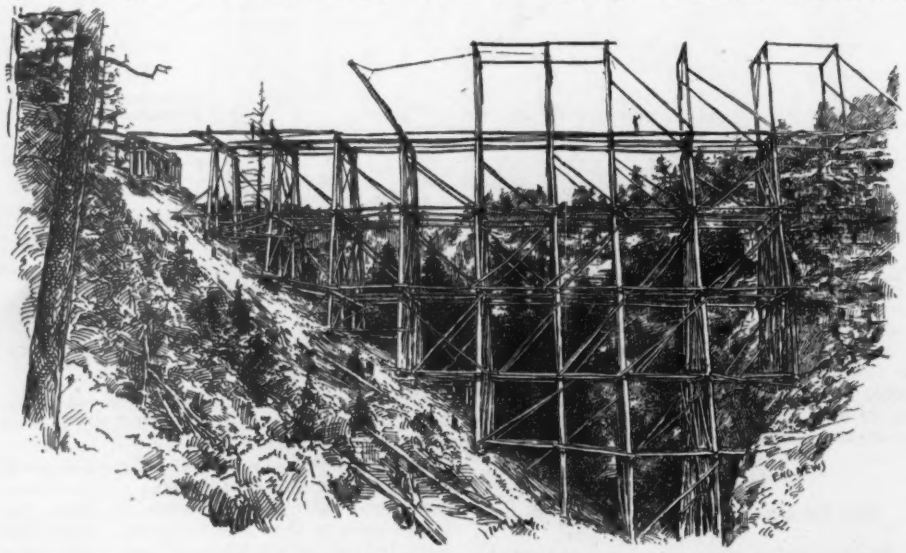
A Lofty Round-Timber Falsework.

We illustrate in the accompanying engravings the falsework for a bridge over one of the cañons of southwestern Colorado. The bridge was a 202-ft.



View of False Work from Edge of Canon.

deck span, with its top chord 142 ft. above the bed of the stream in the cañon. It was built on the line of the Rio Grande Southern R. R., which has been completed this year from Dallas, Col., about 40 miles south, and is eventually to be continued to Durango.



FALSE-WORK FOR BRIDGE OVER PLEASANT VALLEY CANON, IN SOUTHWESTERN COLORADO, ON RIO GRANDE SOUTHERN RAILROAD. C. W. Gibbs, Chief Engineer.

As may be guessed from the photographs, the line is built through a rough, mountainous country. It has maximum grades of 4% and curvature as sharp as 20°. The falsework for the bridge, illustrated in our engravings, was built entirely of round timber cut near the site of the work. Joints were made by hewing the side of the timbers and spiking or drift bolting. For the photographs from which our engravings are made we are indebted to Mr. C. W. GIBBS, M. Am. Soc. C. E., Chief Engineer of the Rio Grande Southern R. R.

Railways in Brazil.

In a report dated June 1, 1890, Mr. ROBT. ADAMS, Jr., U. S. Minister at Rio Janerio, states that the last official report, which treats of the railways up to December, 1887, was issued in 1888. The change in the ministry in 1888, and the revolution of 1889 have prevented the preparation of later reports. The government has for the past few years attempted to obtain clear reports of the railways, but has only in part succeeded, except as to the lines owned by or under the immediate control of the State. In many cases not even the capital of the companies is known.

There are 84 railways classed as follows:

	No. of lines.	No. of miles open.
State	14	1,258
Private companies with general government guaranty of interest	17	1,616
Private companies with provincial government guaranty of interest	18	970
Private companies without guaranty of interest	25	1,348
Suburban unguarantied lines	10	112
Total	84	5,304

About 72 per cent. of the total length belongs to or is aided by the State. At the time of the report 873 miles were under construction, of which 500 miles are now completed, to which must be added over 100 miles of lines of 2 ft. gauge. The system of railways in operation at present comprises about 6,000 miles, and in contemplation (with the plans approved) about 2,500 more. All the new lines are being made on the meter gauge or the agricultural gauge of 2 ft. Freight rates are very high, due partly to the smallness of the traffic, but even with these exorbitant rates many lines are hardly paying their way. In the coffee district, however, the rates on coffee are 10 to 13 cents per ton per mile, and some of the private companies having this traffic pay as much as 12 to 18%. The Central Ry., the principal government line, which runs through the States of Rio de Janeiro and Minas Geraes, is burdened by a large staff of officials and a complicated system of accounts, but manages to pay 5½ to 6% on the capital spent in its construction. The railways are hampered in gaining access to some of the districts which would afford a traffic, by the mountains near the coast. From the port of Santos the trains are hauled over the mountain division by wire ropes up steep inclines of 2,500 ft.; they are then hauled by locomotives to the coffee district, 150 miles inland.

There are seven different gauges in use, as follows:

Gauges.	Miles.
5 ft. 3 ins.	846
4 ft. 8 ins	8
3 ft. 7¼ ins	90
3 ft. 3⅜ ins (1 meter)	3,981
3 ft. 1⅝ ins.	231
2 ft. 4⅝ ins.	136
2 ft. 2 ins.	4
Total	5,304

Rates of Work with Stone-Sawing Machinery.

The Lincoln Iron Works, of Rutland, Vt., give the accompanying table, showing average rates of work with stone-sawing machinery on various classes of work. For the benefit of those not familiar with this class of machinery, it may be said that stone is sawed by reciprocating bars of iron which are continually fed with sand (sometimes chilled shot) and water. The saws are generally mounted in a frame to form a gang, but occasionally a single saw is used for cutting up large blocks. This can be run faster and will therefore cut more rapidly than the gangs, whose results are given in the following table. An asterisk prefixed to the figures in the fourth column denotes that the sand was fed by an automatic device, which is claimed to considerably increase the rate of cutting.

Material.	Locality.	Cutting agent used.	Depth cut in 10 hours, ins.	Remarks.
Granite	Addison, Me	Chilled shot.	10	4 saws.
Granite	Chester, Mass.	Sand.	*12	
Granite	Red Beach, Me.	Chilled shot.	7½	
Bluestone	Hudson River.	Sand.	* 8	
Marble	Carrara, Italy	Sand.	*5	
Marble	Tennessee	Sand.	* 9	45 saws.
Marble	Tate, Georgia	Sand.	*12	10 saws.
Marble	Tate, Georgia	Sand.	* 6	40 saws.
Marble	Gouverneur, N. Y.	Sand.	*12	
Marble	West Rutland, Vt.	Sand.	*20	
Marble	Proctor, Vt.	Sand.	*15	
Limestone	New Point, Ind.	Sand	10	Hard ledge.
Limestone	New Point, Ind.	Sand.	15	Soft ledge.
Limestone	Bedford, Ind.	Sand.	*40	15 saws.
Limestone	Lemont, Ill.	Sand.	*35	14 saws.
Sandstone	North Amherst, O.	Sand.	*40	12 saws.
Sandstone	Clarksville, O.	Sand.	36	
Brownstone	Portland, Conn.	Chilled shot.	20	
Brownstone	Hummelstown, Pa.	Chilled shot.	25	

At the Detroit, Mich., water-works experiments are being made regarding the use of natural gas as fuel at the pumping station. During a ten-days' trial, according to the Detroit *Free Press*, 3,750,000 ft. were consumed, which, at 25 cents a thousand, the present rate, would have cost $937.50. The average cost of coal during a similar period for the five previous years is $824.86 for coal and $78.30 for labor, a total of $903.16, or $34.34 less than the value of the gas used in the experiments. The gas is delivered to the boilers free of cost by the Michigan Gas Co., who hope to so perfect their appliances that they may reduce the expense of gas to less than that of coal. Mr. L. N. Case, Secretary of the water commissioners, estimates that one pound of the coal in use at the pumping station is equal to 9.77 ft. of the gas.

The total of all Westinghouse interests comprising eight companies, among them the air-brake company, was made public last week as follows: Capital issued, $23,170,000; gross earnings, $16,550,000; net earnings, $4,205,000; bonded debt, $1,059,000; other debts, $3,257,900; accounts receivable, $6,297,147; material at cost, $2,560,000.

The occasion of the publication was some temporary financial embarrassment of these companies, requiring the raising of a half-million loan, more particularly for the benefit of the Westinghouse Electric & Manufacturing Co. and the Philadelphia (Natural Gas) Co. To a far greater extent than often happens all of these vast interests may be laid to the creation of one man not yet 45 years of age, if we remember correctly.

A novel plan for keeping switches clear of snow has been put in operation at the terminus of the Suburban Rapid Transit R. R. in this city. A system of steam pipes has been laid along the tracks, and during snow storms a locomotive is stationed at the terminus, and steam from its boiler is blown through the pipes, melting the snow as fast as it falls.

The improvement of the entrance to Galveston Harbor is to be carried out, and proposals for the work were opened Dec. 27, at the U. S. Engineer Office, Galveston, Tex. Congress has appropriated $6,200,000 for this purpose. Two jetties are to be built of sandstone or granite in cement, and along the top of each is to be a standard gage track laid with 56-lb. steel rails. Under the present contract the north jetty will be extended to about 24 ft. of water, and the south jetty to the outer crest of the bar, where the depth is 12 ft.; if necessary, both jetties may eventually be extended to a depth of 30 ft. of water in the gulf. The total bids were as follows: J. H. Mooney and A. M. Newton, of New York, $2,502,870 for sandstone, and $4,029,680 for granite; B. Langtry, of Strong City, Kan., $3,180,560 and $4,913,657; E. H. Gaynor, of Boston, Mass., $3,820,920, and $5,139,230; Southern Construction Co., Galveston, Tex., $3,775,542 and $5,272,674; J. F. O'Connor, J. Laing and E. K. Smoot, of Dallas, Tex., $3,552,315 and $8,282,325.

The new chart of Long Island Sound, made within the last 5 years by the Government, shows many changes from the Hassler chart of 1842, the latest previous survey. Many reefs have since been formed, sunken islands and rocks missed in the old survey have been discovered, and the mean of the tide in the Sound is greater than supposed; it is now fixed at 8 ft. instead of 6 ft. for New Haven harbor. The new chart was sadly needed.

The largest ship-building plant on the lakes is that of the Globe Iron Works at Cleveland. In 1890 there were eleven steel steamships launched from these yards, with a combined carrying capacity of about 31,000 gross tons and a value of at least $2,500,000. Many of these large lake carriers are fitted with triple-expansion engines.

A canal is projected which is to join Knoxville, Chattanooga and Birmingham and give northern Alabama water transportation to the Gulf of Mexico. The object is to develop a region of 5,000 sq. miles, "underlaid with coal and iron," and to reduce freights "from $2.50 to 25 cts. per ton." As the same syndicate proposes "to cover Africa and South America with a network of railways built with Southern steel and run with Southern coal," we are afraid that their projects are too widely scattered to materialize into anything very substantial just now.

Aluminum is not yet on the market at 50 cts. per lb. nor any other price less than the $2 per lb. which is asked for it by the Pittsburg Reduction Co., we are informed by the latter company. The claims said to have been made by the Cowles Company, that they could and would sell it at a material reduction below $2, have not yet resulted in any actual sales at such rates which have come to the knowledge of the only other large aluminum company.

The Mannesmann tube-rolling process is soon to be introduced into the United States, according to report. At the present time the process is in operation at Remscheid and Bons, Germany; Kotomatt, Bohemia, and Landore, in Wales. It is also reported that a company is being organized in Vienna, with a capital of over $8,000,000, for the manufacture of these and other tubes. An American process for producing tubes by rolling is being operated at Findlay, O., by the Kellogg Seamless Tube & Manufacturing Co. This Kellogg process, says the Iron & Steel Association *Bulletin*, differs radically from the Mannesmann process in requring a hollow ingot and a mandrel, and in being limited to a narrower field of products. The Mannesmann machine rolls tubes from a solid bar, and by giving this bar a spiral motion makes the fibers assume a tubular form. The Kellogg machine rolls the metal over a mandrel, which fixes the diameter of the tube formed. But it is stated that the pipes thus formed at Findlay cost much less than lap-welded pipes.

Two 105-ft. steel girders were lately shipped from Pittsburg, Pa., to California, says a Pittsburg paper. The girders weighed about 140,000 lbs. each, and three special platform cars were used in conveying them. The girders were pivoted on the end cars only, the center car being used as a "spacer," and was unconnected with them.

A new Croton dam, on the plan and at the site proposed by Chief Engineer Fteley, is recommended by the Construction Committee of the Aqueduct Commission for immediate construction, as the present Croton dam, which alone stands between this city and a water famine, is pronounced unsafe in case of an extraordinary flood. As elsewhere noted, the Public Works Department of New York is ambitious to take charge of this new dam, and hence is opposed to any further work being inaugurated by the Aqueduct Commission. The matter will probably be fought out in the present session of the Legislature, where a bill abolishing the Aqueduct Commission is likely to be offered by those interested.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

New York Central & Hudson River.—The Mohawk & St. Lawrence R. R. Co., has been chartered in the interest of this company to build the proposed railway from Utica to Clayton, N. Y., about 175 miles.

Titusville, Cambridge & Lake Erie.—Arrangements are being made to build this Pennsylvania railway at once. The roadbed is already graded ready for tracklaying between Erie and Oleopolis, Pa.

Chambersburg & Gettysburg.—The contract for building 6 miles of this 12 mile railway, from Conoco heague to Wolf Hill, Pa., has been let to C. F. Stouffer, Lancaster, Pa.

Michigan Central.—This company has abandoned the project of building a branch to the coal mines at Sebewaing, Mich.

Pennsylvania.—The cross-ties are now being laid on the line from Norrisville to Norristown, Pa.

Western Maryland.—Surveys for the new Potomac Valley R. R., the extension of the Western Maryland R. R. and part of the new system, to be composed of the Baltimore & Ohio, the Reading & Western Maryland lines, have been completed and work on the road will begin in the early spring. The Potomac Valley Co. has just executed a mortage to the Mercantile Trust & Deposit Co. of Baltimore for $2,000,000. The mortgage will cover the line of the Potomac Valley road from Williamsport to Cherry Run and its Pennsylvania extension from Porter's Station on the Western Maryland R. R. to Chickies or the Susquehanna River, and from Abbottstown, also on the Western Maryland, to Bowmansdale on the Harrisburg & Potomac R. R. The execution of the mortgage and the subsequent issue of bonds that will be made under it are in line of carrying out the policy outlined by President J. M. Hood, of the Western Maryland in his last annual report, and noted in our issue of Dec. 6, 1890. The bonds will be ready to be marketed about Jan. 15, and satisfactory arrangements have been made for placing the issue. Each of the extensions named will cost about $400,000, including the construction of bridges over the Susquehanna at Chickies and across the Potomac at Cherry Run.

Gunpowder Valley.—The contract has been let for building this railway from Hoffman to Rockdale, Md., 5 miles. G. W. S. Hoffman, 11 S. Gay St., Baltimore, Md., is President of the company.

New York, New Haven & Hartford.—This company will continue work during the coming year on its improvement of the Shore Line between New York and Boston. One of the most important pieces of work will be the cutting off of the loop at New Haven, Conn., where it is proposed to build a tunnel about 600 ft. long.

Escanaba, Iron Mt. & Western.—All the grading has been completed on the extension from Iron Mt., Mich., to Florence, Wis. The line is already completed from Iron Mt. to Escanaba, Mich., 53 miles. Work on the ore docks at the latter place is now in progress, and an additional force will soon be put at work.

Lehigh Valley.—Work has been suspended on the Buffalo & Geneva R. R. until spring.

Projects and Surveys.

Pennsylvania.—Surveys has been completed for a railway from York to Bowmansdale, Pa.

Fort Plain & Richfield Springs.—Reports are in circulation that the arrangements have all been completed for building the proposed railway from Fort Plain to Richfield Springs, N. Y.

SOUTHERN.—Existing Roads.

Baltimore & Ohio.—P. H. Irwine, of Baltimore, Md., Assistant Engineer, writes as follows:

The Fairmount, Morgantown & Pittsburg R. R. is projected to run from Morgantown, W. Va., via Point Marion and Fairchance, Pa., to Uniontown, Pa., a distance of 33 miles. Of this distance 9 miles are in West Virginia and 24 miles are in Pennsylvania. The surveys have been completed and about one half of the right of way secured. The work will be moderately heavy; maximum curve 10° and maximum grade 66 ft. per mile. There will be one tunnel 500 ft. long, and a bridge over the Cheat River 600 ft. long. The principal business of the road will be in coal and coke.

Seaboard Air Line.—Rapid progress is being made on the Georgia, Carolina & Northern R. R., by which the Seaboard Air Line system of railways obtains a western

connection at Atlanta, Ga. From Chester, S. C., to the Savannah River, 150 miles, the track has been laid, and this section will be put in operation soon. Between the river and Athens, Ga., the grading has been completed and it is expected to have the track laid by March 1, 1891. The bridge across the Savannah River has been completed and work is in progress on the bridges across the Broad and Oconee rivers. Grading is in progress between Lawrenceville and Atlanta, Ga.

Atlantic Coast Line.—Proposals will be received until Jan. 20 for the grading and trestle work on the Wilson & Fayetteville R. R., from Fayetteville to Rowland, N. C., 40 miles. The work will be divided into nine sections. Fleming Gardiner, Wilmington, N. C., engineer in charge.

Norfolk & Western.—Tracklaying has been commenced on the line from the Forks of Elkhorn to Ironton, O.

Roanoke & Southern.—The location from Winston, N. C., north toward Roanoke, Va., is now completed and the engineers will soon commence work on the line from Winston south to Monroe. Two routes will be surveyed for this last line. Surveys will also be made for a cut-off from Salisbury to Mt. Pleasant, N. C.

Projects and Surveys.

South Carolina.—Bills to incorporate the following railway companies have passed the South Carolina State Legislature: The Savannah, Seneca & Western R. R. Co.; Latta Tramway & Mill Co.; Salem R. R. Co.; Little Bluff, Raemont & Maxton R. R. Co.; West End Ry. Co.; Lockhart Shoals Ry. Co.; Anderson & Port Royal Ry. Co.; Western Carolinas Ry. Co.; Greenville Electric Ry. Co.; Charleston & Sea Island R. R. Co.; South Carolina, Seaboard & Western Ry. Co.; Bennettsville & Gibson Station R. R. Co.; Greenwood, Edgefield & Atlantic R. R. Co.; Pickens R. R. Co.; Columbia Electric & Suburban Ry. & Electric Power Co.; Higaland R. R. Co.; Spartanburg, Glendale & Clifton R. R. Co.; Greenville & Paris Mountain Ry. Line, Hotel & Real Estate Co.; River & Seacoast Ry. Co. and the Branchville & Bowman R. R. Co.

Kanawha & Elk River.—D. Ward, 459 Cass Ave., Detroit, Mich., is interested in this railway noted last week.

Bluefield & Princeton.—Surveys for this railway from Bluefield to Princeton, W. Va., have been completed. H. S. Lambie, of Roanoke, Va., is Chief Engineer.

Tullahoma, Elk River & Huntsville.—Chartered in Tennessee to build a railway from Tullahoma, Tenn., to Huntsville, Ala. Among the incorporators are W. M. Staley and Geo. A. Hawkins, of Tullahoma, Tenn.

NORTHWEST.—Existing Roads.

Union Pacific.—It is announced that the Kansas City & Omaha R.R. will build an extension from Kearney to Lincoln, Neb., via McCool Junction.

Projects and Surveys.

Sioux City & Northwestern.—The preliminary surveys for this railway are now completed. In the spring location will begin and it is expected to have a large portion of the line finished during the coming season.

SOUTHWEST. Existing Roads.

St. Joseph & Southeastern.—Work on this road has been abandoned until spring. It will be resumed about April 1.

St Louis, Arkansas & Texas.—This company will make extensive improvements on its lines in Texas during the coming season. The work will comprise the double tracking of the Kansas & Gulf Short Line between Tyler and Lufkin, Tex., and the construction of a 3-mile extension from Lufkin to Rockland, Tex.

Hannibal & St. Joseph.—It is stated that work will soon begin on an extension from Shelbina to Shilbyville, Mo., 23 miles.

ROCKY MT AND PACIFIC.—Existing Roads.

Northern Pacific.—The Green River & Northern Ry. Co. has filed a mortgage of $30,000 per mile on all of its lines of railway, with the Farmers' Loan & Trust Co., of New York City. The lines named are as follows: A line to be constructed from Durham north to the Seattle, Lake Shore & Eastern R. R. near Snoqualmie Falls; a line to be constructed from Palmer west by way of Muchkeshoot Prairie to Stuck Junction; a branch railway now constructed from Durham south to Palmer, a distance of 2.9 miles; a branch railway now constructed from Durham to a point at or near Kangley mine, in King County, a distance of 1.3 miles.

Seattle & Northern.—Permission has been granted to the receiver of the Oregon Improvement Co. to extend this railway to Hamilton, Wash.

Coos Bay, Roseburg & Eastern.—About 300 men are now at work on this line from Marshfield to Utter City.

Union Pacific.—It is announced that this company and the Great Northern Co. will unite in constructing the proposed line from Portland, Ore., to Seattle, Wash., upon which work was stopped some time ago. The grading between Portland and Kalama, Wash., 35 miles, is nearly finished, and the clearing of the right of way between Kalama and Olympia, Wash., is practically completed.

Projects and Surveys.

British Columbia.—The following railway companies will apply to the Canadian Parliament for power to construct railways: The Buffalo Lake & Battleford Railway, Coal & Iron Co., to build a railway from a point on the Calgary & Edmonton Ry. east through the Red Deer country to Battleford. The Alberta Railway & Coal Co., to extend its railway west through the Crow's Nest Pass to connect with the Canadian Pacific Ry. in British Columbia. Messrs. Gemmill & May, solicitors, of Ottawa, on behalf of clients, also give notice of applications for three new railway enterprises. The first is the construction of a railway from the Mission branch of the Canadian Pacific Ry. in British Columbia to Chilliwhack. Another is the construction of a railway from Spence's Bridge, on the Canadian Pacific Ry., southeasterly through the Nicola valley of the western end of the Nicola Lake, with a branch line southerly toward the Chilliwhack. The Crow's Nest & Costenai Lake Ry., which has already been incorporated by the local Legislature of British Columbia, is seeking a Dominion charter. It also asks authority to extend its line of railway from its terminus in the Crow's Nest Pass east to tap the line of the Calgary & Edmonton Ry., and to continue the extension to the towns of McLeod and Lethbridge, Alberta, N. W. T.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are proposed at Covington, Ga.; Boulder, Colo.; Fargo, N. Dak.

Winthrop, Mass.—A public hearing has been given to A. H. Sawtell and others interested in building a storage battery line in this town, connecting with the West End system of Boston. No definite action has been taken on the matter as yet.

Troy, N. Y.—The Troy & Albia Horse Ry. Co. has applied to the State Railroad Commission for permission to adopt electric motive power. This city has already agreed to the change.

Schenectady, N. Y.—Surveys are now being made for the proposed extension of the electric railway.

Oxford, Ala.—T. C. Hill, President of the Oxford Lake line, desires information relative to the construction and operation of an electric railway.

Cincinnati, O.—The City Council has voted to reconsider the vote by which it recently established street railway route No. 24, the College Hill Electric line.

Indianapolis, Ind.—The street railway company has commenced to run smoking cars on its electric lines.

Waco, Tex.—It is reported that a 2½ mile line to Mt. Lynn will be built by the Boston-Waco Land Co.

Galveston, Tex.—It is reported that the Galveston City R. R. is putting in an electric plant for operating its line.

San Francisco, Cal.—The San Francisco Syndicate & Investment Co. has received a franchise for a double track line. C. E. Mayne states that the entire road extending over a number of streets will be built at once. H. Moffat, J. B. Remstein and M. S. Eisner have also received an electric line franchise.

Los Angeles, Cal.—The General Manager of the Pacific Railway Co. is reported as saying that the Los Angeles cable road will be operated by electricity as soon as the Legislature changes a section of the civil code, which apparently prohibits electric lines in the State.

Portland, Ore.—The Barnes Heights & Cornell Mountain Ry. has been organized with $50,000 capital by A. J. Belch, H. Stiles and E. Wilcox. The proposed line will be 2½ miles long and cost $30,000. J. Hale is said to be negotiating to build a 3-mile line costing $100,000.

Spokane Falls, Wash.—B. C. Riblet, of the firm of Riblet & Strack, will have charge of the construction of a 5½-mile, double track electric railway, to be built in this city by the Edison General Electric Co.

Dummy Railway.—*Knoxville, Tenn.*—The City & Suburban Ry. has been chartered by J. C. Harrington, S. Dawes and others who have applied to the city council for a franchise to build a dummy line.

Cable Railways.—*New York City.*—The Metropolitan Traction Co., of Philadelphia, which controls the Broadway and other lines in this city, has voted to increase its capital stock from $10,000,000 to $20,000,000. The money thus obtained will be used in buying property and building the cable road on Broadway.

Brooklyn, N. Y.—The Montague Street Cable Co. is reported to have bought property on which to build a power house.

Portland, Ore.—It is stated that the First St. Co., now operating horse cars, may erect an extensive cable plant and extend its track.

Elevated Railway.—*Toronto, Ont.*—At the next session of the Dominion parliament an application will be made for an act to incorporate the Toronto Railway Viaduct & Tunnel Co., with power to construct an elevated way to relieve traffic along the esplanade.

New Companies.—Elkhorn Motor R. R., Baker City, Ore.; capital stock of $30,000; incorporators F. F. and A. P. Campbell, D. W. Nelson. Milwaukee, Wis., Street Ry. Co.; capital stock, $5,000,000. Dixon, Ill., Street Ry.; capital stock, $150,000.

HIGHWAYS.

Oregon.—The Wapanitia Wagon Road Co. has been organized by I. N. Miller, R. H. Scott, Chas. W. McClown and L. M. Kick to build wagon roads in Wasco Co. Capital stock, $15,000. The office will be at Salem.

New York.—Governor Hill in his annual message renews his previous recommendations with reference to the improvement of country roads. The plan suggested was to construct at the expense and under the supervision of the State, two highways in each county, intersecting at about the middle of the county, or at its principal place, and so connected as to form a network of well built roads through the State. The bill embodying the Governor's plans, which failed at the last session, will again be introduced.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Woonsocket, R. I.*—A bridge will be built across the Blackstone River connecting Sayles St. and Spruce St.

Bridgewater, Va.—A bridge will be built across Dry River. A. B. Glick, Bridgewater.

Harrisburg, Va.—An iron bridge will be built across the Shenandoah River. E. A. Heding, Harrisburg.

Max Meadows, Va.—The Viaduct Construction Co. has been chartered to build bridges.

Knoxville, Tenn.—A bridge to cost $12,000 will be built at this place.

Chicago, Ill.—We are officially informed that bids will not be wanted for the Taylor St. bridge, as stated in our issue of Dec. 20. Also, that work on the plans for the Ogden Ave. viaduct is soon to be commenced. The latter structure will be 450 ft. long and 120 ft. wide.

West Superior, Wis.—Articles of incorporation of the Wisconsin & Minnesota Bridge Co. have been filed. The capital of the company is $75,000. The incorporators are: H. W. Wamsley, W. H. Smith and Charles H. Kinsley, of Superior. The corporation has been formed for the purpose of building and operating a bridge over the St. Louis River between the new towns of St. Louis and New Duluth. It will be a toll bridge.

WATER-WORKS.

NEW ENGLAND.

Auburn, Me.—The following is from G. E. Davis:

The city is making an effort to obtain a better supply, either by buying the works of the company or by building new works. The supply is now inadequate.

Hardwick, Vt.—The Hardwick Aqueduct Co., will probably begin construction in May.

Middlebury, Vt.—C. M. Wilds, chairman village trustees, has sent the following:

The village wishes to sell $30,000 of 4% water bonds. Construction will be started in April. Lang, Goodhue & Co., Burlington, Vt., are Contractors.

Bradford, Mass.—A 1,500,000-gall. reservoir was built in 1890 for the Bradford Water Co., with T. P. Connery as Contractor.

Hamilton, Mass.—O. F. Brown, Town Clerk, informs us that the people recently voted in favor of water-works and appointed a committee to report on the subject at the March town meeting.

Methuen, Mass.—J. S. Howe, Town Clerk, informs us that the water works question is now in the hands of an investigating committee. Works for fire protection only were built in 1876.

Westport, Conn.—W. J. Finch, Town Clerk, informs us that a town meeting will be held Jan. 19 to decide whether works will be built.

MIDDLE.

Albany, N. Y.—The special water commission has received a report from Engineer Verona regarding a gravity supply from the Normanskill. The report proposes a dam 28 ft. high across the stream at French's mill, in the town of Guilderland, which would impound 1,000,000,000 galls. From the reservoir conduits would convey the water to the present Bleecker reservoir. A survey of the drainage area is to be made at once. This source was condemned in 1885 as inferior in quality, and as requiring too large and expensive a reservoir, but it has never been surveyed.

Flatbush, N. Y.—The Martense Water Co., has filed articles of corporation. It proposes to supply water in Flatbush, and its office will be at New Utrecht. W. P. Rae, John Morris and Marcia Dunn are trustees. The capital stock is $10,000.

Rochester, N. Y.—Thomas B. Moore, in behalf of the Pure Water Supply Co., has written to the executive board regarding a supply of from 2,000,000 to 5,000,000 galls. daily which he thinks the company could furnish from a flowing artesian well in the town of Perinton and a pond of 20 acres area, near by. The matter has been referred to the common council's committee on additional supply.

Franklinville, N. Y.—Alfred Spring, Secretary, informs us that the village works were put in operation Jan. 1. The supply is by gravity, and there are 1 miles of mains.

Poughkeepsie, N. Y.—Superintendent Charles Fowler has been authorized to purchase 25 ½ in. meters.

Madison, N. J.—S. B. Leach, of Tarry own, Engineer, informs us that the borough works will be put in operation late in March. Moffett, Hodgkins & Clarke, Syracuse, N. Y., are the Contractors.

Morristown, N. J.—It is reported that the company will build a new reservoir in the spring.

Woodstown, N. J.—W. D. Clayton informs us that final action will probably be taken soon regarding a water works proposition now before the town.

Allegheny, Pa.—In February a vote will be taken on obtaining a new water supply from Nine Mile Island. The estimated cost of the proposed works is $2, 00,000.

Minersville, Pa.—The Forestville Water Co. proposes to build works; capital stock, $'.0.0.

Muncie, Pa.—J. P. Herdic, of Williamsport, General Manager, informs us that company works were put in operation here on Jan. 1. The supply is by gravity and their are 7½ miles of mains.

Philadelphia, Pa.—It is reported that bids will be received until February for 2:,00 00-gall. pumping engines, to be placed at the Spring Garden station.

Pittsburg, Pa.—An appropriation of $75,0.0 for a new reservoir is asked for the 1891 budget.

Milford, Del.—Wilmington capitalists have projected works, including pumps and a stand-pipe.

SOUTHERN.

Basic City, Va.—The Basic City Mining Manufacturing & Land Co will have works in operation Feb 1.

Elm Grove, W. Va.—J. H. Rosenberg, Wheeling proposes to organize a company to bring water by gravity from a spring about 1½ miles from and 150 ft. above the village. The estimated cost of a 6 in. supply main and piping the town is $10,00).

Lincolnton, N. C.—The legislature will be petitioned by the town for the right to issue $20,000 of bonds for water-works and other improvements.

Oxford, N. C.—The following is from J. W. Kittrell:

It is proposed to pump water from Gregory's Run, 7,200 ft. east of and 100 ft. below the town, to a 50,000-gall. tower; also, to put in 7 miles of mains and 70 hydrants. Both Mr. Kittrell and C. W. Wright are interested in the preparation of plans, but the construction is as yet indefinite. Population, 3,000.

Yorkville, S. C.—Some time ago 90% of the taxpayers petitioned the legislature to grant the Town Council authority to issue bonds for water-works. A bill was introduced but became buried near the close of the session. An attempt will be made to secure works in some other way.

Gainsville, Ga.—N. W. Davis, of Atlanta, Engineer, informs us that the town works will be put in operation Jan. 13. The supply is pumped from an infiltration well near a mountain stream to a stand pipe. There are 5¾ miles of mains.

Waycross, Ga.—H. Murphy, President, informs us that the town works will be put in operation in April. No contracts have been let, except for stand-pipe. Population, 3,500.

Leesburg, Fla.—Works are projected.

Birmingham, Ala.—It is reported that the Birmingham Water-works Co. will hold a meeting Jan. 15 to discuss the issuance of $100,000 of bonds.

Huntsville, Ala.—Improvements to cost about $20,000 are projected, and the Legislature will be petitioned by the city for authority to issue bonds.

Scranton, Miss.—Works are projected.

Hillsboro, Texas.—Works are projected.

North Knoxville, Tenn.—The Council has voted to grant a franchise to the Crystal Water Co., but it is thought that the Mayor will veto the ordinance.

Danville, Ky.—Address the Mayor regarding projected works.

NORTH CENTRAL.

Elyria, O.—The town has granted a 20-year franchise for new works to I. W. Newcomer, of Cleveland, the vote having been 4.8 to 205. The new supply will be from driven wells. Works were put in operation in 1879 by the Elyria Gas & Water Co., which took its supply from the Black River. The present supply it is said is unsatisfactory.

Fostoria, O.—The following is from J. M. Howells, of Chicago, Engineer:

It is expected that the works will be completed Feb. 1. The supply is impounded in two reservoirs of 20,000,0.0 and 110,00).0 galls. capacity, and pumped to a 25 × 1.0 ft. stand-pipe, mounted on a masonry base 60 ft. high. The base encloses the pumps, pump well and water-works offices.

Lima, O.—An increase in the storage capacity at an estimated cost of $125,:00 has been recommended by the Water Committee. The question must be decided by a popular vote.

Marysville, O.—G. M. M. Peck, Secretary, informs us that the Marysville Light & Water Co., will put their water-works in operation this month. The supply is pumped from driven wells. Population, 3,00).

Franklin, Ind.—J. J. Hainsworth, of Chicago, Engineer, informs us that the works of the Franklin Light & Power Co will probably be completed in March; estimated cost, $60,000.

Kalkaskia, Mich.—C. M. Phelps, Secretary, informs us that the new city works were completed Jan. 3. Direct pumping is used, and there are 3½ miles of mains.

Belleville, Ill.—We are informed that the city council has revoked the franchise of the old water company and granted a franchise to a new company. The new company proposes to bring the supply from the Mississippi River. The cost of the supply main from this source, exclusive of the distribution system, is $50),000. The cause for revoking the franchise was the company's failure to provide an adequate supply of pure and wholesome water, as the ordinance provides. For some time the city has been without any supply whatever. The ordinance provides that $15,000 per annum shall be allowed the new company for hydrant rental. The old company was paid $7,500 the first year, but the rental was reduced $',000 each succeeding year. Because of the city's bonded indebtedness it can legally make a contract for but one year at a time.

Duquoin, Ill.—An abundant supply of soft, pure water has been obtained, and a system of water works will soon be established.

Rock Island, Ill.—The city has contracted for a 3,000,-000-gall. Jewell filter.

Antigo, Wis.—Advices from both E. La Londe, City Clerk, and A. W. Stevens, of Logansport, Ind., Constructing Engineer, state that the works of the Antigo Waterworks Co. will have its works in operation about Jan. 20. Water is pumped from a well to a stand-pipe.

NORTHWESTERN.

Dubuque, Ia.—The purchase by the city of the Dubuque Water Co.'s works continues to be discussed.

Sioux City, Ia. Proposals will be received until Jan. 13 by L. H. Drumm, Chairman Water Committee, for a new pumping plant with a daily capacity of not less than 2,500,000 galls.

Independence, Kan.—A 500,000-gall. American filter has been contracted for, to be in operation by March 30.

Grand Island, Neb.—George Loan, Superintendent, informs us that at least three miles of new mains will be added in the spring; also that additional wells will be sunk, but the kind has not been determined.

Sutton, Neb.—A. A. Richardson, Lincoln, Engineer, informs us that the construction of town works will be started Apr 11. All the contracts have been let.

Wayne, Neb.—F. L. Fuller informs us that contracts will probably not be let before February, owing to a defect in the bonds, of which there are $18 000 5% 5-20's.

Canton, S. Dak.—Contracts for town works have been let, and construction will be started March 1. A. A. Richardson Lincoln, is Engineer.

Vermillion, S. Dak.—W. W. Smith informs us that efforts are being made to secure works on the franchise plan.

White Sulphur Springs, Mont.—The following is from A. Boongard, Mayor:

Works will be built by a local company and most of the necessary money has been subscribed. The supply will be pumped to a stand pipe from a large spring about 3 miles from town. Population 750. Address T. S. Ash or B. R. Sherman.

SOUTHWESTERN.

Columbia, Mo.—Hiram Phillips informs us that as soon as the trouble regarding the issue of bonds is disposed of, probably in February, an engineer will be employed and works will be built. The village has voted $15,00) of bonds for water and electric lighting works, but an injunction prevented their immediate issuance.

Macon, Mo.—Charles Farrar, City Clerk, informs us that the city works will be completed Feb. 1; cost, $21,000.

Mound City, Mo.—J. M. Hasness, Clerk, informs us that the new town works will be put in operation Feb. 1; cost, $11,000.

Palmyra, Mo.—J. C. B. Thomas, mayor, informs us that the works of the Palmyra Water & Light Co. will be completed about Feb. 1; cost, about $5),000.

Comanche, Tex.—Address the mayor regarding projected water-works.

Akron, Col.—Works comprising a pump, stand-pipe and about four miles of mains have been completed and tested.

Elyria, Col. (Denver, P. O.)—The trustees have unanimously voted to grant a franchise to the Denver Water Co., of Denver. The town will take 50 hydrants.

PACIFIC.

Hoquiam, Wash.—F. E. Burlew has sent the following:

The Northwestern Lumber Co. has works for its own use, and has extended them to meet the wants of the town; but it has recently notified the town that it cannot supply water later than spring. O. P. Burrows has proposed to make a survey for a new supply. F. D. Arnold is Mayor

Montesano, Wash.—It is reported that works are again projected.

Port Townsend, Wash.—The following is from A. W. Bash, President:

The Mount Olympus Water Co., at present operates a small pumping, and is now closing a contract for gravity works with the United States Construction & Pipe Mfg. Co. of San Francisco. The new supply will be from Quilcene River H. B. Smith, Victoria, B. C., is Engineer.

Forest Grove, Cornelius and Hillsboro, Ore.—P. O. Chilstrom, Secretary, has sent the following:

The Gales Peak Water Co., of Forest Grove, proposes to construct works next spring and summer The supply will be from two creeks, about 3½ miles from and 155 ft. above Forest Grove. It is estimated that works to supply Forest Grove would cost $33,000, and that the extension to Cornelius, three, and Hillsboro, six miles, would cost at least $20,000 more. Preliminary surveys have been made by R. A. Habersham, Portland C. M. Keep is President. Forest Grove has a population of 1,200 Cornelius 600, and Hillsboro, the county seat of Washington Co., 1,500.

Salem, Ore.—J. M. Martin, Superintendent, has sent the following:

The Salem Water Co. are preparing to build a 2,000,000-gall. reservoir in the spring and to extend the mains beyond South Salem to Fairmount Park. The reservoir will be 200 ft. above the business part of the city. It will be 135 × 200 ft., × 10 ft. deep, with 20 in. walls of brick in cement, backed by a stone wall.

Anaheim, Cal.—The Baker Iron Works of Los Angeles has made a proposition regarding a new pump.

Fresno, Cal.—A new 4 000,000-gall. Gasked pumping engine has been added, under the supervision of Consulting Engineer J. M. Howells, of Chicago.

CANADA.

Cote Saint Paul, P. Q.—The council has unanimously voted to grant a 25-year contract to the Montreal Island Water & Electrical Co. The company is to set hydrants every 500 ft., and supply water to them free.

FOREIGN.

Buenos Ayres, Argentine Republic.—It is reported that the Argentine Government has offered to buy the water-works of a company, paying about $3,000,000 in 5% bonds.

ARTESIAN WELLS.

Washington, Ia.—The artesian well is down 700 ft.

Cisco, Tex.—Bids for sinking an artesian well are wanted by the town.

IRRICATION.

Pendleton, Ore.—The following is from R. L. Adams, who made preliminary surveys:

The Umatilla Irrigation Co. proposes to construct a flume and ditch having a combined length of 45 miles, and leading from the Umatilla diver to land at the north and west of Pendleton. A bill, granting the company righ of way over the Umatilla Indian reservation, is now before Congress, and if it passes at this session work will probably be started in the spring.

Blackfoot, Ida. The Blackfoot Irrigation Co. has been organized with a capital stock of $15,000. G. A. Robethan and William Howard are among the directors.

Teton, Ida.—The Teton Irrigation and Mfg. Co. has been organized, with J. P. Jones, Frank Graham and others, of Teton, as directors. Capital stock, $10,000.

SEWERAGE AND MUNICIPAL.

Sewers.—***Manchester, N. H.***—More pipe sewers are needed. The mayor in his message states that half of the cost of the sewers should be assessed to abuttors on the streets through which the sewer passes; while to prevent political influence he advocates that the construction should be done by contract.

Newton, Mass.—The new sewerage ordinance has been passed, regulating the method of assessment.

Woonsocket, R. I.—The mayor in his message has recommended that immediate steps be taken toward a complete system of sewerage.

Pawtucket, R. I.—The mayor in his message refers to the pollution of the Pawtucket river by the sewage, and recommends steps for sewage disposal and utilization.

Newark, N. J.—During 1890 there were 3.506 ft. of brick sewer built, 4.21 miles of pipe sewer, 90 basins, 159 manholes and 1 flush tank; the cost of this work was $79,804. There are now 51.40 miles of brick and 43.76 miles of pipe sewers, 1.780 basins and 20 flush tanks. The amount of sewage pumped was 2,542,717,144 galls., an average of 7,028,219 galls. per day, with an average coal consumption of 2,328 lbs.

Pittsburg, Pa.—The city engineer, Mr. Taylor, has been instructed to prepare plans for a sewer in Berlin alley. Work will not be commenced until April.

Roanoke, Va.—It is proposed to issue bonds for sewers for $10),000.

Park Ridge, Ill.—Surveys have been made and plans and specifications prepared for a complete system of sewerage, by C. McLennan, C. E., of Chicago, Ill.

Lemont, Ill.—Surveys and plans for a system of sewerage are to be prepared by Vanderlip & Blenkensop, of Chicago Contracts will be let about April 1.

Kenosha, Wis.—A system of sewerage is projected and a report on the question is to be made to the city by Mr. John Lundie, C. E., of Chicago, Ill.

Grand Forks, No. Dak.—It is expected to extend the sewer system next season to the extent of about $50,000. W. S. Russell is city engineer.

Victoria, B. C.—The Sewerage Commissioners have awarded the contract for the construction of the sewerage system to McBean & Co., of San Francisco, Cal., at $245,970. Work will be commenced in March.

Streets.—***Long Island City, N. Y.***—Mr. Van Alst, engineer of the Improvement Committee, has submitted estimates as follows for macadamizing: Jackson Ave., $218,631; Vernon Ave., $330,230; the Boulevard, $69,810.

Dunkirk, N. Y.—Street improvement is needed, but no definite action has been taken. Some favor the plan of each person paving for the work in front of his own premises, whether macadam, brick or stone pavement; while others endorse the present plan of levying a continual 6-mill tax to help every street pay one third of the cost of its improvement.

Nashville, Tenn.—The city will apply to the Legislature for power to issue $2)),000 in bonds for street work.

St Joseph, Mo.—The city has ordered the St. Joseph Gas & Fuel Co. to put the streets in condition after they have been torn up for laying the company's mains.

Gas.—***Nashville, Tenn.***—The city proposes to issue bonds for $600,000 for constructing new gas works or for purchasing the plant of the Nashville Gas Light Co.

Garbage.—*Savannah, Ga.*—The first tests of the Engel garbage crematory are said to have resulted satisfactorily. Wood is used for fuel.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are proposed at Comanche, Tex., address Fort Worth Construction Co.; Beaumont, Tex.; Mansfield, Pa., address Dr. Langford; Dayton, Tex., address the mayor; Little Rock, Ark., address the mayor; Madisonville, Ky., address the mayor; Harrisonburg, Va., address E. L. Conrad; Reidsville, N. C., address the mayor; Gibson, Ill.; Beaver, Pa., address J. J. Davidson.

Newark, N. J.—During the past year the streets have been lighted by 3,400 gas lamps at $19 and $20 per lamp year and 434 arc lights at $145 per light year of 4,000 hours.

Wheeling, W. Va.—F. Barrett and others are reported to be organizing a $50,000 stock company to establish a lighting plant.

Wilson, N. C.—The town recently authorized the issue of $75,000 of water-works and electric light bonds. Mayor G. D. Green can give further information.

Cincinnati, O.—The City Council will take no action on electric municipal lighting until the State Legislature has considered the matter of underground wires.

Columbus, O.—The Clerk of the Board of Public Works has been instructed to advertise for bids on 800 or more lights of the same power as those now in use.

Indianapolis, Ind.—The following bids have been received for street lighting:

Bidders.	No. of lights.				
	400	500	600	700	800
Western Elec. Co..... { 5 years	$120	$115	$112	$110	$105
{ 10 years	115	110	107	105	100
Marmon & Perry Co.... { 5 years	115	115	112.50	112.50	110
{ 10 years	110	110	107.50	107.50	103
Brush Light & Power Co.... { 5 years	105	103	102	101	130
{ 10 years	99	98	97	96	95

Warsaw, Ind.—The town has contracted with the Warsaw Electric Light & Power Co. for 25 arc lights of 2,000 c. p. at $65 per lamp year on a five-year contract.

Kenosha, Wis.—The City Council has contracted with the Electric Illuminating Co., of Chicago, to light the city every night until 1 A. M. with 60 arc lights of 2,000 c. p. at $82 per lamp year. The company also offered the same number of lights on an all-night schedule at $90, and on a moonlight schedule at $76.

New Companies.—Riverside, Ill., Edison Co.; capital stock, $10,000. Prouty Street Car Motor Co., Chicago, Ill.; capital stock, $500,000. Idaho Electric Light & Power Co., Wallace, Idaho; capital stock, $500,000; incorporators: C. W. O'Neill, F. C. Loring and others. Bell Rock Electric Conductor Co., Malden, Mass.; capital stock, $500,000; incorporators, A. Cook, Dr. Nutter, L. J. Rodier and others. Wilmington, Ill., Electric Light & Power Co.; capital stock, $21,000; incorporators: D. J. Courval, J. H. Campbell, J. H. Ray. Lampasas Springs, Tex., Electric Light & Power Co., capital stock, $20,000. Monon Electric Light & Power Co., Homestead, Pa.; capital stock, $10,000; incorporators, J. Hollingshead, J. S. Shaffer, P. Fry and others.

CONTRACTING.

Pipe and Castings.—*Boston, Mass.*—The Water-Works Department has awarded a contract for cast-iron water pipe and special castings to R. D. Wood & Co., of Philadelphia, Pa., at $27.95 per ton of 2,240 lbs., for 30 tons of 4 in. pipe, 70 tons of 6-in., 300 and 1,000 tons of A and B 12-in., 200 tons of 24-in., 1,100 tons of 30-in. and 150 tons o special castings. Total, $38,663.

New Bedford, Mass.—The Water Board has awarded a contract for cast-iron water pipe and special castings to the McNeal Pipe & Foundry Co., of Burlington, N. J., at $27 per ton of 2 240 lbs., for pipe (7¼ tons of 3-in., 66 tons of 6 in., 11 and 53 tons of light and heavy 8 in., 35¼ tons of 10 in., and 97 tons of 20-in.), and 2⅜ cts. per lb. for 7,500 lbs. of special castings. Total, $7,473.

Dredging and Stone.—*San Francisco, Cal.*—The following proposals have been received by Col. G. H. Meedell, U. S. Engineer Office, for dredging 500,000 cu. yds. in tidal channel, dredging 600,000 cu. yds. in tidal basin, laying 50,000 sq. ft. of dry masonry, and for 110,000 tons of stone for jetties: San Francisco Bridge Co., 22.7 and 16 cts. per cu. yd. for channel and basin dredging, 14.6 cts. per sq. ft. for masonry, $1.74 per ton for stone. Pacific Coast Dredging Co., San Francisco: 14½ cts. per cu. yd. for all dredging. Van Schmidt & Mahee, San Francisco; 16 and 12.39 cts. for channel and basin dredging. A. Boschke, San Francisco: 15 and 9¾ cts. for channel and basin dredging. John Kelso & Co., San Francisco: 14 cts. per sq. ft. for masonry and $1.70 per ton for stone.

Stone.—*Portland, Ore.*—Proposals have been received by Major T. H. Handbury, U. S. Engineer Office, for furnishing 150,000 tons of rock for the jetty at the mouth of the Columbia River. N. J. Blagen, 77 cts. per ton; Peter Hinkle, 75 cts.; Joseph Smith, 61 and 63½ cts.

Sidewalks.—*Oakland, Cal.*—The prices of bids received by the council for cement walks on Jefferson Square and round the City Hall, ranged from 13 to 15 cts. per sq. ft.; and 30 to 50 cts. per lin. ft. for curbing.

Sewers.—*Pittsburg, Pa.*—Statements of cost of new sewers have been prepared by the Department of Public Works at the following prices: 18-in. pipe sewer, $1.60 per lin. ft.; 15 in. pipe sewer, $1.01 and $1.15 per ft.; manholes, $28 to $33 each; drops, $60 each; masonry, $14 per cu. yd.; castings, $1.98 per 100 lbs.

PROPOSALS OPEN.

Pipe.—*Baltimore, Md.*—About 4,187 tons of 14-in. to 36-in. cast-iron pipe; cast-iron pipe fittings, brass stops and ferrules; special brass and iron castings. The Water Department.

Dredging.—*New York, N. Y.*—About 24,000 cu. yds. at Pier 23 North River, Jan. 13; about 8,000 cu. yds. at Pier 12, East River, Jan. 15. The Department of Docks, Pier A, North River.

In Great Chazy River, N. Y., 29,000 cu. yds. of clay and boulders, 18,000 cu. yds. of sand. Mayor M. B. Adams. U. S. Engineer Office, Burlington, Vt. Jan. 29.

Sewer.—*Washington, D. C.*—Concrete sewer in Edgewood subdivision. The District Commissioners. Jan. 27.

Breakwater.—*Chicago, Ill.*—At U. S. marine hospital, Lakeview. J. H. Windrim, Supervising Architect, Treasury Department, Washington, D. C. Jan. 14.

Electric Light Plant.—*Norfolk, Va.*—For the Navy Yard. N. H. Farquhar, Chief of Bureau, Navy Department, Washington, D. C. Jan. 13.

Lighting.—*Cincinnati, O.*—Gasoline lighting on streets. Edwin Henderson, City Clerk. Jan. 30.

Pumping Engine.—*Pittsburg, Pa.*—Duplex pump of 500,000 galls. daily capacity, 20 ft. head, 70 ft. piston speed, 90 lbs. steam pressure. E. M. Bigelow, Chief of Department of Public Works. Jan. 15.

Water-Works.—*Springhill, N. S.*—Plans and specifications on file. Daniel McLeod, Town Clerk. Jan. 20.

Buildings.—*Fort Payne, Ala.*—County court-house. Architects, Chamberlin & Co., Knoxville, Tenn. L. L. Cochran, Judge. Feb. 9.

Slayton, Minn.—Court house. Architect, F. Thayer, Mankato, Minn. C. E. Weld, County Auditor. Feb. 4.

Street Work.—*New York, N. Y.*—Regulating, grading, curbing and flagging. Department of Public Works, 31 Chambers St. Jan. 15.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have an order for 3 eight-wheel passenger engines, with 76-in. driving wheels and 7 ten-wheel freight engines for the Baltimore & Ohio; they have built some consolidation engines for the Richmond & Danville. H. K. Porter & Co., of Pittsburg, Pa., have built a 36-in. gage engine for the United States Government, to be used on the line for the improvements at Sandy Hook; they have also completed a 24-in. gage engine for a plantation road in the West Indies. The Schenectady Locomotive Works, of Schenectady, N. Y., have completed 2 engines for the Chicago, Milwaukee & St. Paul; the works turned out 337 engines during 1890. The Brooks Locomotive Works, of Dunkirk, N. Y., are building some engines for the Atchison, Topeka & Santa Fé. The Rhode Island Locomotive Works, of Providence, R. I., have orders in hand for engines for Canada, Mexico and South America, besides those for this country. The Illinois Central added 89 engines to its equipment during the past year. The Sullivan Hardware Co., of Anderson, S. C., wants a 6 or 8-ton narrow gage engine. The New York, Providence & Boston and the Staten Island Rapid Transit will give orders for more engines.

Cars.—The Barney & Smith Mfg. Co., of Dayton, O., is building mail and express cars for the Minneapolis & St. Louis. The Ohio Falls Car Co., of Jeffersonville, O., has a capacity of 5,000 freight cars per annum. The Columbia Steel Car Co. will build works at Riverview, near Des Moines, Ia., with a capacity of about 20 cars per day. The Georgia Rolling Stock Co. has been organized to build car works at Macon, Ga. The Western Rolling Stock Co., of Chicago, has been organized by Geo. E. Farley, G. S. Wheeler and Wm. E. W. Johnson; capital stock, $100,000. The Rodger Ballast Car Co., of Chicago, has brought out an improved car for ballast, coal, ore, etc. The Illinois Central added to its equipment during the past year 65 passenger cars, 1,500 coal cars of 30 tons capacity, 1,000 box cars of 25 tons capacity, 10 baggage cars, 50 ft. long, 10 postal cars and 150 refrigerator cars. The Southern Pacific, Northern Pacific, Wisconsin Central, Baltimore & Ohio and New York, Providence & Boston railways will give out orders for freight cars.

Station.—A new railway station is to be built at Newington, Conn., on the New York & New England.

Station Indicators.—The Grand Trunk Ry. is equipping some of its passenger cars with indicators showing the names of the stations. After each stop the conductor moves a lever on the indicator, a gong is sounded and the name of the next station appears in the frame.

Filters.—The city of Rock Island, Ill., has awarded the contract for filtering the water supply of 3,000,000 galls. daily to the Morison-Allen Co., of New York, and the Jewell Filter Co., of Chicago. A Morison-Allen filter of 250,000 galls. daily capacity will be put in at the Manhattan Athletic Club, New York.

Pipe Works.—The Radford Pipe and Foundry Co., of Cincinnati, O., has commenced the construction of its works at Radford, Va.: pipe foundry, 269 × 126 ft.; special foundry, 54 × 178 ft.; machine shop, 49 × 98 ft.; engine room, 49 × 40 ft.; boiler house, 70 × 38 ft.; pattern shop, 84 × 24 ft.; blacksmith shop, 40 × 22 ft.; heating and tarring shop, 33 × 50 ft.; proving house, 38 × 67 ft.; hay rope shop, 54 × 24 ft. President, James A. Gamble; Vice-President, W. A. DeArmond; Secretary and Treasurer, A. Brown; General Manager, J. K. Dimmick; Assistant to President, W. T. Partridge. Capital stock, $350,000.

Valle & Young, of the Maryland Galvanized Iron Works, Baltimore, Md., have removed their works and offices to a new building at 216 North Calvert St. Baldwin & Pennington were the architects, and S. H. & J. F. Adams, the builders. The firm makes a specialty of patent metallic skylights, with a system of glazing without putty.

The Missouri Valley Bridge & Iron Works, of Leavenworth, Kan., have recently furnished a 100 ft. Pegram's patent truss bridge to the Missouri Pacific Ry. They have a contract for a 65-ft. single span bridge, weight 730 lbs. per lin. ft., under Mr. George H. Pegram, Bridge Engineer of the Missouri Pacific Ry., for the International & Great Northern Ry.; the material for this bridge has recently been satisfactorily inspected by the Pittsburg Testing Laboratory, and is to be put into position at once.

The King Iron Bridge & Mfg. Co., of Cleveland, O., is shipping the iron to Chicago for the Washington St. viaduct. This is to be a roadway bridge with two spans of 64 ft., one of 45 ft. and one of 80 ft. It will also furnish the structural iron for the new park house in Lincoln Park, Chicago. John Lundie, the Rookery, Chicago., is the Western agent.

The Berlin Iron Bridge Co. will build the iron roof for the extension of the rolling mill of the Lackawana Iron & Coal Co., at Scranton, Pa.; the company is erecting the new casting shop for the Midvale Steel Co. at Nicetown, Pa., and has put up the iron roof of a new muffle room for the Scovill Mfg. Co., of Waterbury, Conn.

Welding Machine.—The Thomson Electric Welding Co., of Boston, Mass., has furnished a machine to the Salem Wire Nail Co., of Findlay, O., for welding bundles of steel wire for making nails.

The Consolidated Car Heating Co. has removed its main offices at Albany, N. Y., from the Commercial Bank Building to its shops on Trinity Place.

The Niagara Water Motor Co., of Brooklyn, N. Y., which owned the patents of David Williamson, has been dissolved, by permission of the Supreme Court. P. J. Carlin, Andrew D. Baird and Theodore B. Willis were among the stockholders.

The Pennsylvania Machine Co. has been organized at Philadelphia, Pa., to succeed the H. B. Smith Machine Co. in the general machinery business. President, J. J. White.

New Companies.—United States Projectile Co., of New York, to manufacture shells under the Cayley-Korthman patents; incorporators, E. W. Bliss, D. F. Lewis, H. D. Polhemus and Nelson F. Carman, Jr.; capital stock, $500,000. Globe Iron Works, of New York, to manufacture car wheels, railway iron work and machinery; incorporators, Wm. E. Rice, A. C. White and E. C. White; capital stock, $50,000. Burton Columbian Tower Co., of Chicago, to build a tower 1,492 ft. high; incorporators, Chas. C. Burton, Geo. M. Ludlow and E. B. Tolman; capital stock, $1,000,000.

Metal Market Prices.—*Rails.*—New York: $28; old rails, $22 for iron and $20 for steel. Pittsburg: $27.50 to $28.50; old rails, $25 for iron, and $17.50 to $18.50 for steel. Chicago: $30 to $31.50; old rails, $22.50 for iron and $18.50 to $19 for steel.

Foundry Pig Iron.—New York: $16 to $17.50. Pittsburg: $15.25 to $17; Chicago: $14 to $15.50.

Track Materials.—New York: steel angle bars, $1.65 to $1.75; spikes, $2 to $2.10; track bolts, 2.7 to 2.8 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2.05 cts. for iron, 2.1 to 2.15 cts. for steel; iron or steel spikes, 2.1 cts.; iron track bolts, 2.9 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 1.95 to 2.05 cts. for iron and 2.15 to 2.25 for steel; spikes, 2.15 to 2.20 cts.; track bolts, 3.05 cts. with hexagon nuts.

Pipe.—Cast iron, $27 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap welded. Casing, 50 per cent.

Lead.—New York, 4.45 cts. Chicago, 4.25 to 4.30 cts. St. Louis, 4.05 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles 2.05 to 2.10 cts.; tees, 2.6 to 2.75 cts.; sheared iron plates, 2.20 to 2.25 cts.; steel plates, 2.25 to 2.30 for tank, 2.55 to 2.65 cts. for shell, 2.85 to 3 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.25 cts.; tees, 2.85 cts.; universal iron mill plates, 2.3 cts.; sheared steel bridge plates, 2.45 cts.; refined bars, 1.9 to 2 cts.; steel plates, 2.35 cts. for tank, 2.70 cts. for shell, 2.90 cts. for flange, 4.25 to 4.50 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.35 to 2.4 cts.; tees, 2.9 to 3 cts.; universal plates, 2.45 to 2.5 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.8 to 2.9 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.